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Standards for Production Control—I

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Small shops have often hesitated to install incentive systems because of the difficulty of establishing equitable standards on limited production. Allowances based on classes of work rather than on individual operations simplify the problem of rate setting

DATA presented in this article illustrate a practical method for establishing wage incentive standards, which may be started in a modest way and added to as required. The plan, in brief, is the consideration of groups or classes of work rather than individual operations. Each work class is separately analyzed and studied to obtain the most efficient operating conditions possible. Time studies representative of the work class are then made, from which planning and timesetting standards are carefully constructed. These standards can then be turned over to a relatively inexperienced planning clerk, who will route the work through the shop, specify tools and methods, and calculate time allowances in accordance with the standards.

This plan is adaptable to the small plant, manufacturing a variety of products, where the number of parts processed at a time is small. Such a plant cannot afford an elaborate timestudy department but, nevertheless, must operate efficiently and produce parts at low cost. The method is equally adaptable to the large manufacturer whose operations are greatly curtailed at present, but who desires to put these operations on an economical basis and to develop an adequate planning department that may be prudently expanded as his volume returns.

There are some classes of work which lend themselves more readily to standardization than others. Where operations are performed on automatic or semi-automatic machines, it is a comparatively simple matter, after establishing operating conditions, to calibrate the machines and collect a few time studies to determine the handling time for various sizes of parts and to prove the feeds and speeds. These data may then be used to make up timesetting standards in the form of constants, equations and charts from which rate allowances can be quickly set to a satisfactory degree of accuracy by inexperienced help.

Gear Cutting Analyzed

There is a distinct advantage in beginning the installation of methods in a work class of this sort where the standards may be put into practical use almost at once and with such accurate results that the operator will immediately earn some bonus. Workers in other departments will not fail to find out this fact, and they will be anxious to have their own groups put on similar methods. Thus the antagonism and lack of cooperation frequently met with in the introduction of new ideas will be eliminated at the start. In the actual application from which the following illustrations have been taken, the gear cutting department was selected as the first to be put on incentive. The first group studied was the gear shaper group.

Since it is necessary to the high degree of accuracy required in the product, to have the gear cutters in good condition at all times, only minor corrections were found necessary in conditioning the machines to cut at highest practical speeds. The cross slide of the oldest machine in a group of three, was found to be worn in the center, producing a slight discrepancy in the alignment of the cutter spindle. This alignment was so small it was decided not to rescrape the rail at the time, but to confine the use of the machine to roughing cuts and to the finishing of gears not requiring the highest accuracy. An investigation of the grinding of the shaper cutters disclosed the fact that the use of a finer grade grinding wheel resulted in smoother cutting edges and that lightly stoning the cutting face of the cutters increased the average length of service between grinds by nineteen per cent.

After calibrating the machines and providing a machine specification chart on each for the convenience of the operator and the planning clerk, the next step was the making of the time studies. Using the best available feed and speed data, the machines were set for top production, the studies were taken on all machines for several days, to establish cutting conditions, handling constants and idle times. The methods engineer used three timestudy watches in these determinations to account fully for all elapsed time on each machine. During this period a close check was

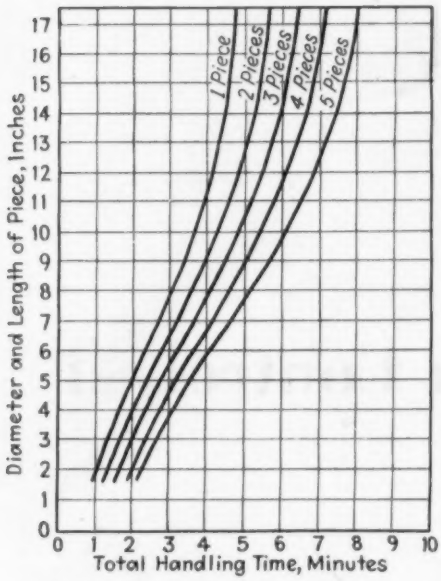

Fig. 1—Handling time for Fellows gear shaper

kept with the inspection department, and adjustment of cutting conditions was made as indicated by the results.

After a sufficiently representative collection of studies was at hand, the next step was to analyze the studies with a view to establishing standards to be used as a basis for setting incentives. A tabulation of total handling times for all jobs studied was made, and these times were plotted against the dimensions of the work. A preliminary survey showed that the total handling time varied almost directly with the diameter and length of the piece. Variations in diameter and length of the bore also affected the handling time to a lesser extent, but inasmuch as the bore varied directly with the diameter in most of the cases studied, the sum of the outside diameter and the overall length of the gear was used to construct the handling time chart shown on Fig. 1.

All of the points plotted did not fall on the curves as drawn, nor were there actual examples covering the complete range of sizes and number of pieces per chucking. By neglecting exceptionally high or low values from consideration, however, and using the average of the examples which were truly representative, the law governing the relationship between the three variables was established, and the chart was constructed as shown.

A study of the high and low values revealed that there was considerable variation of bore size in the gear blanks. As a result of this discovery, proper tolerances for internal diameters were established by the engineering department, "go" and "not-go" gages were provided, the reamer practice was changed to use adjustable blade tools

Gear Cutting Data

No. 61-A Fellows gear shaper

Work capacity: External spur gears, 18 in. P.D. × 5 in. face × 4 D.P. Internal spur gears, 18 in. P.D. × 3 in. face × 5 D.P.

Cutters: Use 4 P.D. cutters with 1¼ in. hole for 6 pitch and coarser gears. Use 3 P.D. cutters with 1¼ in. hole for 7 pitch and finer.

Motor speed: 1800 r.p.m.

Main drive shaft speed: 1250 r.p.m.

Lubricants: Use two parts refrigerant base to eight parts paraffine oil on steel. Cast iron is cut dry.

Blanks must be accurately machined, hole square with faces, and concentric with outside diameter.

Table I—Feed in strokes per rev. of cutter

	Feed—One cut		
Pitch	4-6	8-12	16 up
C.I.	1440	1260	1080
Steel	1620	1440	1260
Brass	1440	1260	1260

	Feed—Two cuts—Two settings		
Pitch	4-6	8-12	16 up
C.I.	1080	900	900
Steel	1440	1260	1080

	Feed—Two cuts—Two settings			
Pitch	4	10	12	16
Cut	Rgh	Fin	Rgh	Fin
C.I.	1080	900	900	900
Steel	1440	1260	1260	1080

Finer feeds must be used where rigid support is lacking. For highest quality gears, use two cuts, confine number of pieces per setting so that stroke does not exceed 3 in.

For small lots, two cuts on same machine should be taken, while on large lots the gears should be roughed on one machine and finished on a second machine. For ordinary or low quality, they may be finished in one cut.

In making up instruction sheets, consult Fellows chart for change gears and pitch gear. Select cutter, number of cuts, and number of pieces per setting, after careful consideration of the gear cutting data.

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which could be easily and economically maintained to a close degree of accuracy. These steps emphasize the value of the job-analysis aspect of time study, where the discovery and remedying of unstandard conditions is accompanied by improved accuracy and quality, increased production and decreased cost.

From the cutting conditions established by and recorded in the studies, the feeds and speeds shown in Table I and Fig. 2 were adopted as standard practice. These speeds were found to be maximum commensurate with quality required. As new materials come into use, these standards will be added to.

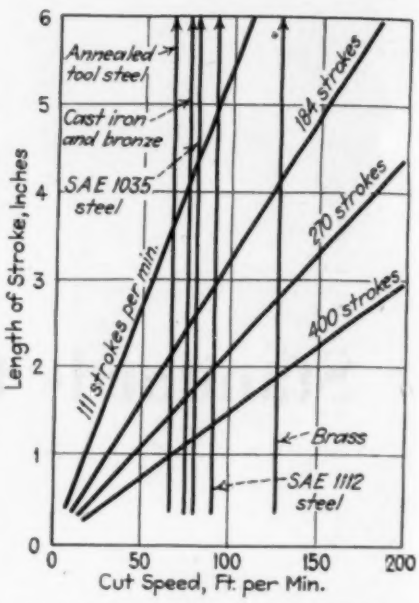


Fig. 2—From the length of stroke and the cutting speed, the strokes-per minute may be found

Since the data are to be applied by relatively inexperienced clerks, who will ultimately have a great number and variety of allowances to set, it is essential to be able to compute quickly the time for the cutting cycle. From practical experience in a number of applications, the author has concluded that the alignment chart is less expensive to construct, simpler to use, speedier to operate and more accurate in result, than any other method of computation for the purpose. The use of equations and tables takes too long, and the chance of error is great. Special slide rules are expensive, difficult to construct, and are hard for the average individual to understand and apply.

Chart Shows Cutting Time

The chart for the solution of the time cycle of the Fellows gear shaper is shown in Fig. 3. The equation of this particular machine is

$$M = \left(\frac{\text{Tooth depth}}{0.0018} + \frac{N_g S_{rc} K}{N_c}\right)\frac{1}{S_m}$$

where M is the total time in minutes, N_g is the number of teeth in the gear, N_c the number of teeth in the cutter, S_{rc} the feed in strokes per revolution of the cutter, S_m the cutting speed of the cutter in strokes per minute, and K the number of cuts required. The operation consists of two parts, feeding to depth and then shaping the teeth in either one or two revolutions of the work, depending on whether one or two cuts are required. The time to feed to depth is found by dividing the whole tooth depth by the amount of infeed per stroke (0.0018 in.) to obtain the total number

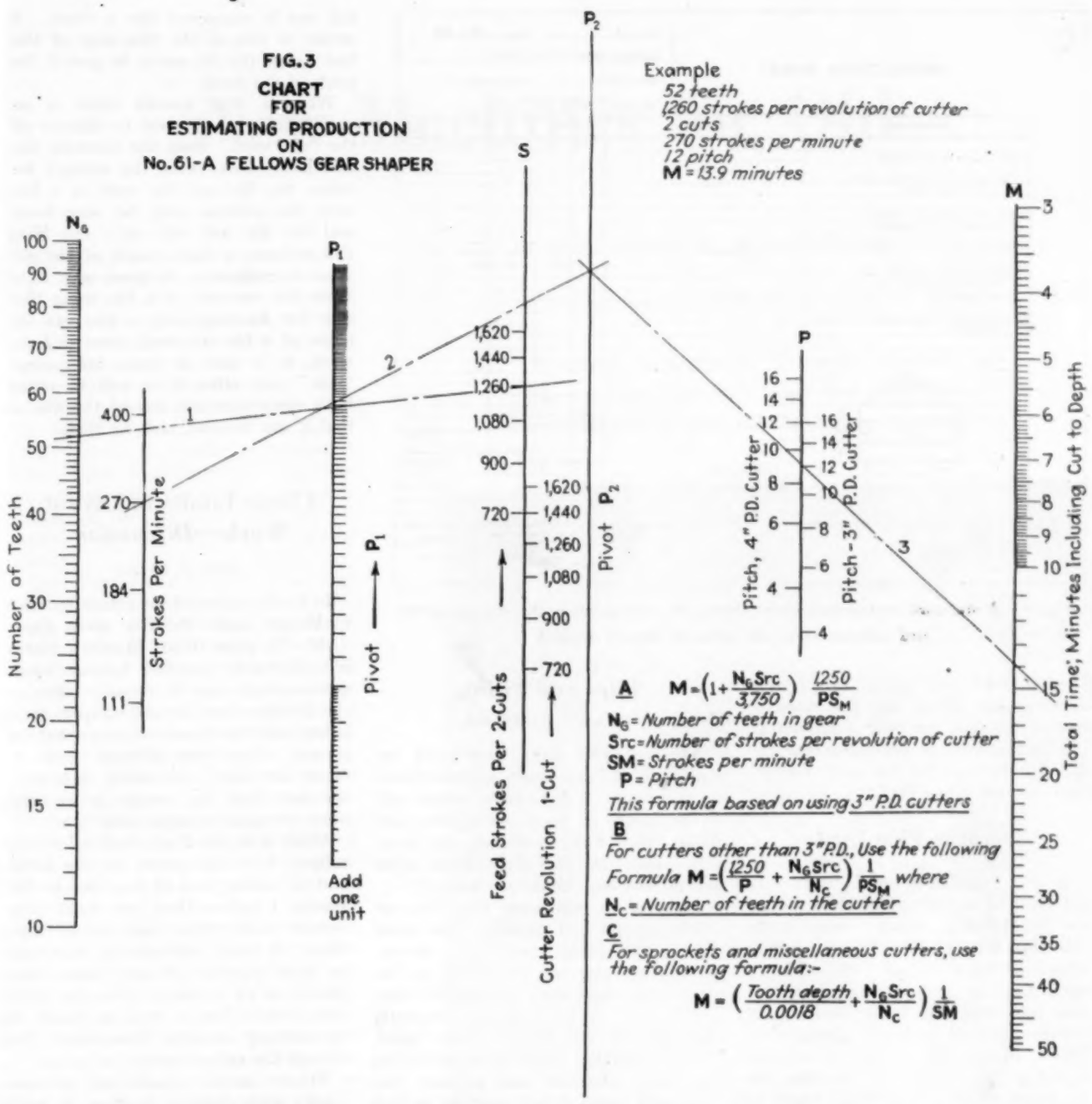


FIG. 3
CHART
FOR
ESTIMATING PRODUCTION
ON
No. 61-A FELLOWS GEAR SHAPER
Example
52 teeth
1260 strokes per revolution of cutter
2 cuts
270 strokes per minute
12 pitch
M = 13.9 minutes
Number of Teeth
Strokes Per Minute
Pivot
Add one unit
Feed Strokes Per 2-Cuts
Cutter Revolution 1-Cut
Pivot
Pitch, 4" P.D. Cutter
Pitch - 3" P.D. Cutter
Total Time, Minutes Including Cut to Depth
A $M = \left(1 + \frac{N_G S_{rc}}{3750}\right) \frac{1250}{PS_M}$
N_G = Number of teeth in gear
Src = Number of strokes per revolution of cutter
SM = Strokes per minute
P = Pitch
This formula based on using 3" P.D. cutters
B
For cutters other than 3" P.D., Use the following
Formula $M = \left(\frac{1250}{P} + \frac{N_G S_{rc}}{N_c}\right) \frac{1}{PS_M}$ where
N_c = Number of teeth in the cutter
C
For sprockets and miscellaneous cutters, use the following formula:-
$M = \left(\frac{\text{Tooth depth}}{0.0018} + \frac{N_G S_{rc}}{N_c}\right) \frac{1}{SM}$

of strokes necessary, and then dividing this value by the number of strokes per minute. The time for a complete revolution of the work is found by multiplying the feed in strokes per revolution of the cutter by the ratio of number of teeth in gear to number of teeth in cutter (revolutions of cutter per revolution of work), and dividing this result by the number of strokes per minute. From the consideration that whole depth of tooth in any gear in the Fellows system is equal to the constant 2.250 divided by the pitch, and that three and four inch pitch diameter cutters are standard for the gear shaper, the above equation reduces to:

$$M = \left(1 + \frac{N_g S_{rc}}{3750}\right) \frac{1250}{PS_m}$$

for 3-in. P.D. cutters, and vary approximately to:

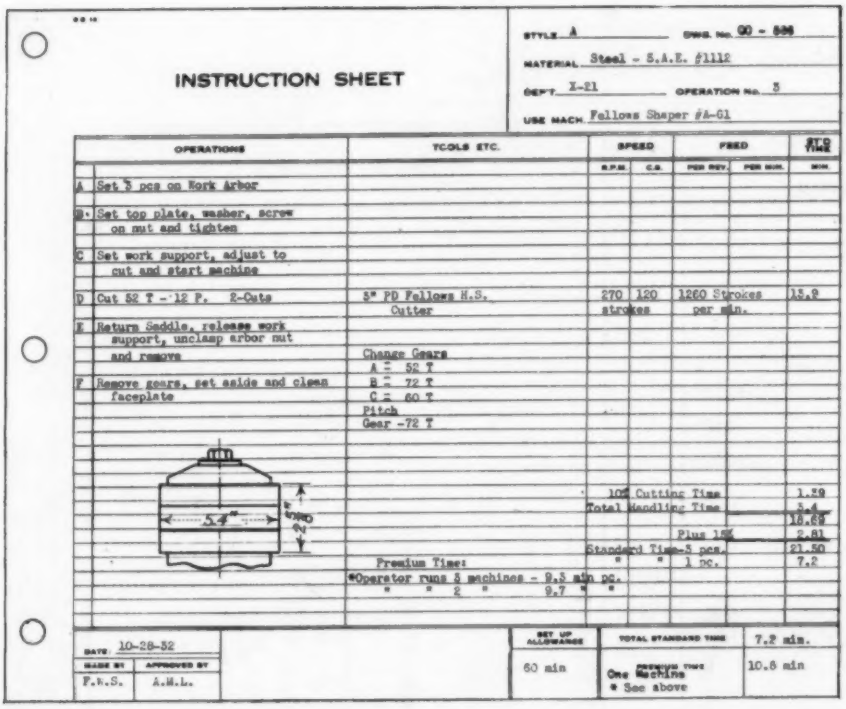
$$M = \left(1 + \frac{N_g S_{rc}}{3750}\right) \frac{1250}{\frac{4}{3} PS_m}$$

for 4 in. P.D. cutters.

The use of the standards can be explained best by working through an example. A plain cold rolled steel face gear has dimensions as follows: 7/8-in. face, 5.4-in. O.D., 12 pitch, 52 teeth. The gear is required to be most accurate. In making up the instruction sheet, the planning clerk consults the cut speed chart and feed table and specifies the use of a cutting speed of 270 strokes per min. with a feed of 1260 strokes per revolution of the cutter. Further reference to the table suggests the use of two cuts in one setting with a 3-in. cutter, and the cutting of three gears per setting.

The cutting time is found from Fig. 3 as follows: Project a straight line through 52 on the N_g scale and 1260 on the S_{rc} (two cuts) scale. Raise the point of intersection of this line with the P_1 scale by one unit, and through this point and 270 on the S_m scale, project a straight line to intersect the P_2 scale. Through the point on P_2 scale, project a straight line through 12 on the P (3 in. cutter) scale and find the total time of 13.9 min, on scale M.

The total handling time per chucking is found from Fig. 1, to be 3.4 min. These times are entered on the instruction sheet, percentages to cover varia-



INSTRUCTION SHEET

STYLE A DWG. No. 90 - 886
MATERIAL Steel - S.A.E. #1112
DEPT. X-21 OPERATION No. 5
USE MACH. Fellows Shaper #A-61

	OPERATIONS	TOOLS ETC.	SPEED R.P.M.	SPEED C.S.	FEED PER REV.	FEED PER MIN.	SET & TIME MIN.
A	Set 5 pcs on Work Arbor						
B*	Set top plate, washer, screw on nut and tighten						
C	Set work support, adjust to cut and start machine						
D	Cut 52 T - 12 P. 2-Cuts	5" PD Fellows H.S. Cutter	270 strokes	120	1260 Strokes per min.		13.2
E	Return Saddle, release work support, unclasp arbor nut and remove						
F	Remove gears, set aside and clean faceplate	Change Gears A = 52 T B = 72 T C = 60 T Pitch Gear -72 T					
						10% Cutting Time	1.32
						Total Handling Time	3.4
							18.62
						Plus 15%	2.81
						Standard Time-5 pcs.	21.50
		Premium Time:				" " 1 pc.	7.2
		*Operator runs 3 machines - 9.3 min pc. " " 2 " 9.7 " "					

DATE 10-28-52
MADE BY F.H.S. APPROVED BY A.H.L.

SET UP ALLOWANCE 60 min

TOTAL STANDARD TIME 7.2 min.
One Machine 10.8 min
* See above

Fig. 4—A standard instruction sheet shows the set-up, gives the change gears and indicates how the allowed time is derived

tions of feed and speed, and fatigue allowance are added, and the standard time of 7.2 min. per gear is arrived at. This is the average per piece time the operator is expected to meet for the total quantity to be cut.

Incentive Plan Used

In the installation under discussion, the plan of incentive payment in use was the Halsey premium system. Under this plan the operator is given a time allowance for a certain task, with the understanding that savings from the time allowance will be divided equally between himself and the management. The rates are set so that the average operator can increase his regular rate by about 25 per cent. Thus where an operator runs one machine, 50 per cent is added to the standard time to get the premium allowance. In the group under discussion, the operator runs three machines, so that an extra incentive is provided to keep all three going as much of the time as possible. The amount added to get the premium allowance, based on two machines, is 35 per cent per machine, and for three machines, is 30 per cent per machine. Thus if the operator succeeds in keeping three machines producing at standard rate, his own earnings are increased by $3 \times 30 \div 2 = 45$ per cent. The other 45 per cent goes to management.

A copy of the instruction sheet, Fig. 4, is issued with the tool for the job.

(To be continued)

Files and Filing

WILLIAM S. ROWELL

Although files have been used for thousands of years—they are mentioned in the book of Job—there seems still to be much to learn about files and filing. How many workmen can properly name the files they want when several different kinds are wanted?

Most of us will agree that files are often misused and abused. The abuse starts with piling them in a drawer, where they damage themselves as the drawer is jerked open and pushed shut.

Files used by lathemen are frequently damaged by too high a work speed. This is especially likely to be so in filing crystalline material, such as cast iron. The work speed should never be as high as the return stroke of the file, thus an appreciable cleaning action takes place on a light return stroke. This cleaning should be supplemented by frequent brushing, or by other methods adapted to the class of material being filed. In no case should any file be allowed to gather and hold particles of the material being filed; in other words, to "pin." A skilled workman becomes very sensitive and is able to detect the presence of "pins" by the lack of smoothness of the back stroke. Cleaning a file that has been used on soft metal is best done with a thin piece of sheet copper or brass. A favorite tool is a piece of tubing of suitable diameter and material, split and flattened at one end, the other end serving as a handle. The flat end is sharpened like a chisel. A stroke or two of the thin edge of this tool across the file serves to give it the pitch of the teeth.

When a very smooth finish is required, it is usually best to oilstone off the "cat teeth" from the finishing file. For lathe work, since the contact between the file and the work is a line only, the oilstone may be used freely and the file will still cut. For filing flat surfaces, a light touch of the oilstone is sufficient. A good way is to stone but one side of a file, using that side for finishing only. Also, as the edges of a file are rarely used in lathe work, it is best to have both edges "safe," and often it is well to round both corners on one side of the file, so that it can be used next to fillets.

Closer Limits in Layout Work—*Discussion*

JOHN E. HYLER

In his discussion of the article by Hart F. Wright under the title given above (*AM*—76, page 1075), Matthew Harris is undoubtedly justified, because where measurements can be directly taken on the dividers from vernier calipers there is but half the chance of errors that are present where two different measurements are taken and added, aside from the fact that the vernier is so much more accurate to begin with.

While it is true that nearly all vernier calipers have the points on the beams and the sliding jaws as described by Mr. Harris, I believe there are many other vernier instruments that do not have them. It would undoubtedly be a point in good practice if such points were placed on all verniers. Then the layout man would find a tool available for transferring accurate dimensions, even though the calipers might be in use.

Where much transferring measurements with dividers is done, it would seem that even a better method might be developed. Why transfer the measurement from one tool to another before application to the work? I have wondered at different times if it would not be entirely feasible to design a pair of micrometer dividers that could be accurately set to any desired dimension. It seems to me that such a tool could be made something along the line of the beam compass, one point being solidly mounted, while the other could be slid along the graduated beam. A small eccentric device could be added for close adjustment, and the instrument could be periodically checked by the vernier points for accuracy. Possibly I am on the wrong track, but if so I would like to know why.

New Machines for Old

OREN G. RUTEMILLER
General Engineer,
Westinghouse Electric & Manufacturing Company

Electrical equipment, properly applied, is the modern Aladdin's lamp that transformed an obsolete planer into an up-to-date miller

TODAY we are advised to rehabilitate our plants and equipment as a step toward the return of business stability. However, we are warned that any improvements we make or any new equipment that is purchased should be self-liquidating in a short period of time.

In many plants there are large tools that might be replaced with new equipment, making it possible to produce a better finished product; but often the thought of replacing these machines is abandoned because large tools are expensive and cannot be liquidated quickly.

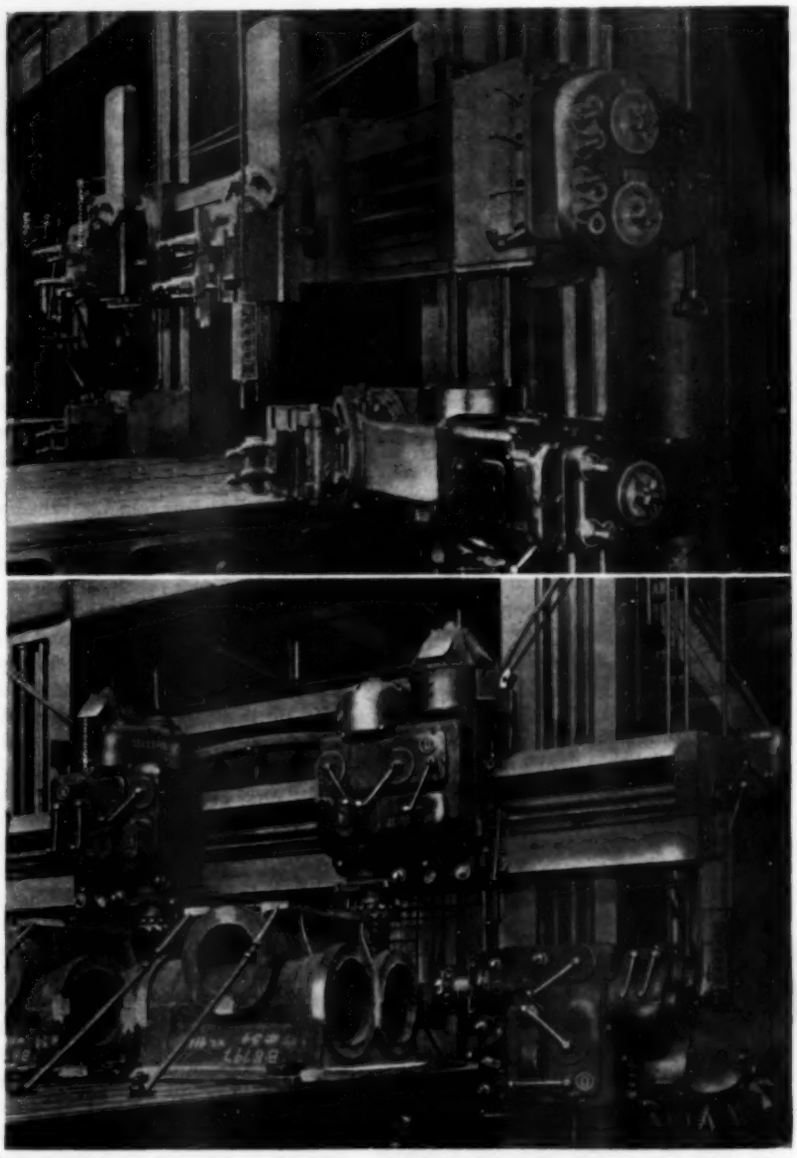
The recent rehabilitation of a large machine tool represents an excellent example of the possibilities of modernizing a large machine at a cost which is much less than that of a new machine. This represents an example of what might be done, and the principle may be applied not only to machine tools but to many classes of large machinery.

An 8-ft. planer was recently converted into a 10-ft. planer type milling machine by one of the machine tool builders who specializes in large machines. This conversion was accomplished without removing the bed of the machine from its foundation. The uprights, crossrail, table and cross girt were shipped to the machine tool builder where extensions were added to each side of the table and filler blocks were added to the bottom of the uprights to allow the wider table to pass between them. A new cross girt was made; a new crossrail and four new milling heads were added. Then the entire machine was reassembled at its ultimate location.

Mechanical Drives Simplified

The use of the flexibility that is inherent in correctly applied electrical equipment is partially responsible for the success of this project. The machine tool designer with the assistance of the electrical equipment manufacturer made full use of the possibilities offered by individual motor drives for each motion. These eliminated the necessity of many cumbersome mechanical drives and undoubtedly made it possible to effect the conversion at the least cost.

Each of the four milling heads is driven by a constant speed d.c. motor



Before and After. **A close-up of the crossrail and side heads shows their appearance on the old planer and on the modern milling machine**

which is mounted directly on the head. A number of gear changes makes a variety of spindle speeds available. The use of individual motors mounted on the heads eliminates the necessity of a complicated system of splined shafts paralleling the uprights and the crossrail which would otherwise be required to supply power to the spindles. Furthermore, the elimination of the maze of shafting paralleling the uprights and crossrail resulted in a much better appearance as will be noted from the illustration of the completed machine.

Splined Shafts Eliminated

The feed mechanism for the heads that are mounted on the crossrail is driven by a constant speed d.c. motor through a Westinghouse-Wise four-speed gear motor. This mechanism imparts both vertical motion to the quill in each head and horizontal motion to the heads along the rail. This same motor also provides power traverse to the heads and quills. A single back gear at the end of the crossrail and the four-speed Westinghouse-Wise drive make eight feeds available. The crossrail feed motor is mounted on the rear of the crossrail at one end and moves up and down with it. This arrangement eliminates splined shafts paralleling the uprights which would otherwise be necessary for the feed drives. A new arrangement of screw and nut drive for the rail-head horizontal feed makes it necessary to have only one splined shaft and one screw shaft paralleling the crossrail.

The feed drive for the side heads is obtained by means of an adjustable speed d.c. motor mounted on the cross girt. Power is transmitted to the side heads by a splined shaft paralleling each column. A back gear, together with the adjustable speed motor, makes a wide range of feeds available.

The table is driven by an adjustable speed d.c. motor mounted on the foundation at the rear of the machine. Change gears provide two feeding speed ranges and a fast traverse speed.

Crossrail elevation is accomplished by a motor which drives conventional screws which parallel the uprights. This motor is mounted on the cross girt.

Lubricating and coolant pumps are provided, each being individually driven by a d.c. motor.

The flange mounted spindle drive motors and the mounting of the four-speed gear motor used for rail-head feed impart an appearance to the machine that indicates the electrical equipment has been engineered into the machine and not placed as a necessary evil and an afterthought.

The electrical control equipment, which was specially designed for application to this machine, deserves particular notice. This control equipment was built from standard parts merely assembled and wired in special combination.

An operator's control panel forms one end of the control cabinet. It is believed that this is the first time this particular type of construction has been used for machine tool controllers.

The operator can safely control all spindle motors from a single pushbutton because the position of the pistol grip handle on the spindle selector switches gives a visual indication of which spindles will start and the direction of rotation. The spindles that are operating are stopped by depressing a single pushbutton also located in the pendant pushbutton station. All reversing is accomplished by electrically reversing the direction of rotation of the various motors.

All of the various motors are fully interlocked to prevent inadvertent operation which might cause damage to the tools, the work or the machine. No part of the machine may be operated before the lubricating pump is started. This insures a supply of lubricating oil to all of the various mechanisms whenever they are operated.

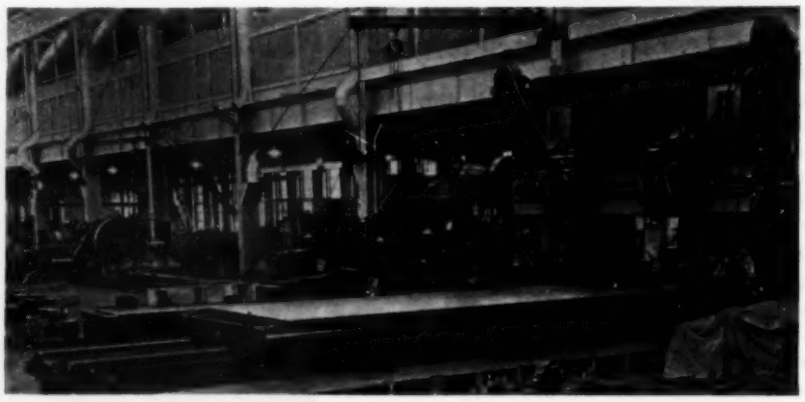
On any milling machine, one of the most important interlocking features that is required is that which prevents feeding the work into a cutter that is not rotating. This would be almost sure to result in a damaged cutter or spindle or both. This machine is interlocked so that the cutters that have been selected by means of the spindle selector switches must be running before any feed motors can be started. Furthermore, the entire machine will be automatically stopped if any spindle motor should stop for any reason. This interlocking is positive; it is not sufficient to have completed the necessary set-up circuits, the spindle motors must be running.

However, it is possible to start or stop an individual spindle while others are running if the spindle interlock button is held depressed while so doing. This enables the operator to stop a cutter that has completed a cut before others or to start one that has not been cutting. This can only be accomplished by a deliberate action on the part of the operator. Rapid traverse motions are possible at all times. This is deemed advisable to facilitate set-up work.

The crossrail elevating motor is interlocked with the clamp preventing the movement of the crossrail while this clamp is set.

A unique system of overload protection on the spindle motors prevents the operator from overloading the cutters. If the load on any one of the spindle motors exceeds 125 per cent of full load, all feed motions are slowed down. If the load decreases the speed of the feed motors is again increased to the former setting. This system operates on overloads of short time duration. If the load on the spindle exceeds 115 per cent for a period of time long enough to endanger the motor all spindle drive and feed motors will be stopped.

After this machine was completed, a thorough test was made of this overload control system. A cutter was arranged to take a moderate cut in a billet. With moderate feed speeds, the machine operated at the speeds selected. However, when the speed was increased slowly a point was reached when the overload devices became effective. When the feed speeds were increased above this point the final resultant speed of the feed mechanism was equal to the maximum allowable feed for the given conditions regardless of the setting of the speed control devices. In other words, when the load on the spindle motor was increased above 125 per cent, the feed motor was slowed down thus causing the load to become lighter and the feed motor was again speeded up. This adjustment of the feed motor speed



Individual motor drives simplified mechanical construction thus lightening the task of rehabilitation

gave a final resultant speed equal to that required for good cutter operation. Perfect protection for the cutter and the feed mechanism was thus obtained, and it is impossible to overload either long enough to cause damage.

After the spindles that are to be used are selected and the coolant and lubricating pumps are started, the machine is almost entirely controlled from pushbuttons. The only exceptions to this are the controls for the feed and spindle speeds which are by means of gear change levers and the rheostat knobs. Also the table traverse motion is controlled from a lever conveniently located at the side of the table.

Two pendant pushbutton stations are used thereby providing for operation from either side of the machine. These pushbuttons control the starting and stopping of the spindle motors that have been selected and the feed motion of the table. A number of limit switches disposed about the machine limit the travel of the various parts thereby preventing damage caused by overtravel of these parts.

Thus a large machine was modernized and made more useful by rehabilitation. Modern versatile machine designers can thus perform transformations of character as well as create new machines.

A Small-Shop Kink—*Discussion*

GEO. D. TAYLOR

Referring to the article by Charles H. Willey under the title given above (*AM*—Vol. 75, page 898) and the several discussions thereon as to which is the better machine for the job, the shaper or the milling machine, Robert S. Alexander tells (*AM*—Vol. 76, page 1157) how by using a ⅛-in. thick slitting saw of high-speed steel in the milling machine and taking the precautions he mentions, the ⅜-in. plates would be minus their 1 in. of excess stock in short order.

To me, the term "in short order" is rather vague and meaningless. Wishing to know just what is the very last word in speed and feed for a saw of high-speed steel, I searched several handbooks; also the indexes of the *AM* as far back as 25 years. I failed to find any mention of higher speeds than those listed in the B & S tool catalog. These were, for machine steel, from 80 to 100 per min., or 95 r.p.m. for a 4-in. diameter saw, and a possible feed of from 3½ to 4 in. per min. in a cut ⅜ in. deep, or from 0.037 to 0.042 in. per revolution.

Next, I visited several shops where saws of high-speed steel were used and inquired what speed and feed a ⅛-in. saw of high-speed steel would stand. One man said that with a saw 4x⅛ in. he could saw a slot ⅜ in. deep and 12 in. long in 25-point carbon steel in 4 min., or at a feed of 0.032 in. per revolution. This would be at the rate of 5.4 min. for a length of 16.2 in., which includes the 15 in. length of plate, plus 1.2 in. for the approach of a 4-in. saw.

To find the time for handling one piece, I took a piece of wood veneer as a substitute for a plate, using a stop watch to catch the time, which was 1 min. from floor to floor. This would make a total time of 6.4 min. for handling and milling one plate, or 76.8 min. for twelve plates, according to this man's guess.

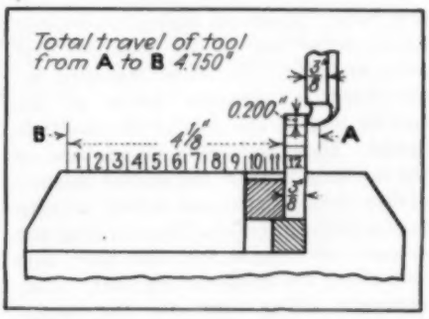
Another man guessed he could cut a slot of the same depth in the same material, 15 in. long in 6 min., or at the rate of 16.2 in. in 6.48 min. Adding 1 min. for handling this time would be 7.48 min. for one plate, or 89.76 for twelve plates. Still another man said that a 4x⅛-in. saw of high-speed steel could be run at from 150 to 175 r.p.m. in a cut ⅜ in. deep with a feed of from 0.005 to 0.006 in. per revolution, if well lubricated. At 175 r.p.m. and a feed of 0.006 in. per revolution, the time for the saw to travel 16.2 in., plus 1 min. for handling, would be 16.4 min. For twelve plates this would amount to 196.8 min., or 3.28 hours.

As the above were estimates, and not very satisfactory, I strapped a piece of ⅜x7¾-in. 25-point carbon steel on the milling machine table. With a 3½x⅛-in. carbon-steel saw running at 52 r.p.m., well oiled, I cut off a strip in 5 min. Hand feed was used to the limit of just not letting the saw slip on the arbor. As there was no keyseat in the arbor, the collars were tightened on the saw by holding the belt and striking the overhang of the wrench several times. The feed was about 0.030 in. per revolution. To get a faster feed, the saw would have to be keyed to the arbor. For a travel of 16.2 in. the time would have been 10.45 min., and adding 1 min. for handling would have brought it up to 11.45 min. For twelve plates the time would have been 137.4 minutes.

With but one exception, no one cared to run the saw faster than a surface speed of 100 ft. per min.; also, no one cared to crowd the feed. As one foreman said, "Customers object to paying for broken saws, so we play safe." All agree that a carbon-steel saw would stand as much, if not more, feed and grief than would a saw of high-speed steel.

Next, a piece of the same kind of steel, but 15 in. long, was put in the vise of a 16-in. shaper, edge up, and a ⅜-in. square, high-speed toolbit was set to cut 0.200 in. deep. The shaper was run at 30 strokes per min. and the feed was adjusted to about the limit the belt would pull. After this test a cut was taken across the work and the shaper was allowed to run until the tool had traveled 4⅛ in. farther, this distance representing the total thickness of eleven plates (see sketch). Allowing ¼ in. for the approach of the tool, the total distance traveled by the tool was 4.75 in., requiring 93 strokes of the shaper, or 3.1 min. Since five cuts would be necessary to remove the excess metal from twelve plates, the total cutting time, including that for the approach of the tool, would be 15.5 min. Adding the time for returning the tool to the starting point after each cut and setting it for the depth of cut, the total time would be slightly less than 20 minutes.

To equal the time of the shaper, the milling machine would have to cut the pieces from twelve plates in 20 min. Since the twelve plates would require 12 min. for handling, but 8 min. would be



How the tests were made to find time required to shape 12 pieces

left for the actual cutting, so that the saw would have to travel 16.2 in. in 40 sec., or at the rate of 24.3 in. per minute.

The feed that I obtained with the carbon-steel saw in the milling machine was about 0.030 in. per revolution, and is, I think, about the best feed for the depth of cut. At this feed, to cut 24.3 in. per min., the saw would have to run at 810 r.p.m.

I hold no brief for either the shaper or the milling machine and would use the faster machine wherever possible. For the job referred to, use the shaper.

The experiments noted above were carried out in the machine shop of the Davis Vocational Technical School at Grand Rapids, Michigan.

Multi-Blade Cutting Tools

Their Design and Use—I

R. R. WEDDELL
The O. K. Tool Company

It looks like an excellent time to review the subject of multi-blade tools. Their use has greatly widened during the past few years and will continue to do so as the wheels of industry accelerate. This article is the first of a series that will cover many ramifications of the subject including cutting angles, feeds and speeds, and maintenance of core drills, reamers, facing heads, hollow drills and combination tools

ROTARY multiple-pointed tools are as old as the metal-working industry itself. Methods of taking combined cuts, as in the use of drills and reamers, were invented even before machine tools. A more recent development is the multi-blade tool with inserted cutting edges for machining a single diameter or several diameters capable of removing a volume of metal beyond the capacity of any single-pointed tool. Another type has a series of blades set to do facing or hollow milling in combination with boring operations.

Such tools are aptly called combination tools. Their use makes a veritable turret lathe out of an ordinary drill press or lathe. The chief operating requirement is adequate power at the spindle to pull the cuts of the multiple blades. These tools save set-up time on the machine because the correct relation of diameters, lengths and depths is taken care of in the grinding. They machine two or more surfaces at the same time, thus shortening the total cutting time. They eliminate sizing time, for the correct sizes of the part to be made are ground into the tool. Furthermore, because of multi-blade construction, size will be held for larger quantities or lots than when single-pointed tools are used.

Fig. 2 shows a double boring tool. Here two sets of blades are set into a single cutter body to bore two different diameters. The cutter construction is identical to that of a single head except that possibly fewer blades are used for boring each diameter than would be the case if a single cutter was used.

This leads to the principal consideration for design of combination tools—the number of blades for each operation. An even number should be used, if possible, to facilitate measuring. There should be the same number, or a multiple thereof, for each diameter. That is, if eight blades are used for the larger diameter, the smaller diameter should have eight, four or two blades. These blades should be evenly staggered between themselves; in no case should the blade slots be extended to carry another set of blades. With such construction, it is impossible to lock both sets of blades, for as one is tightened, it will open up the slot and loosen the other. Cutter bodies may be made with a solid shank or with a bore, depending on the diameter of the tool. Provision for ample strength should be made between the blades themselves and between the blades and the bore.

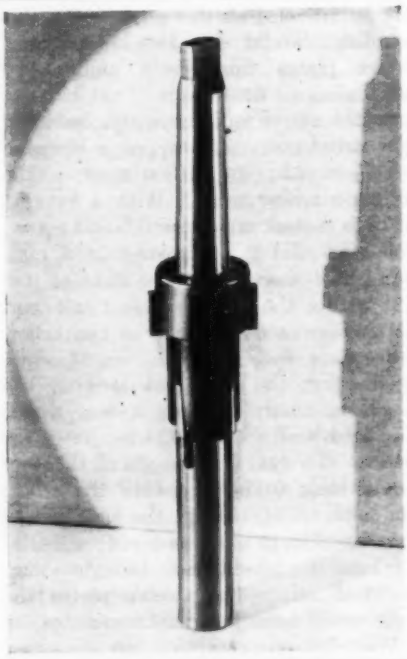
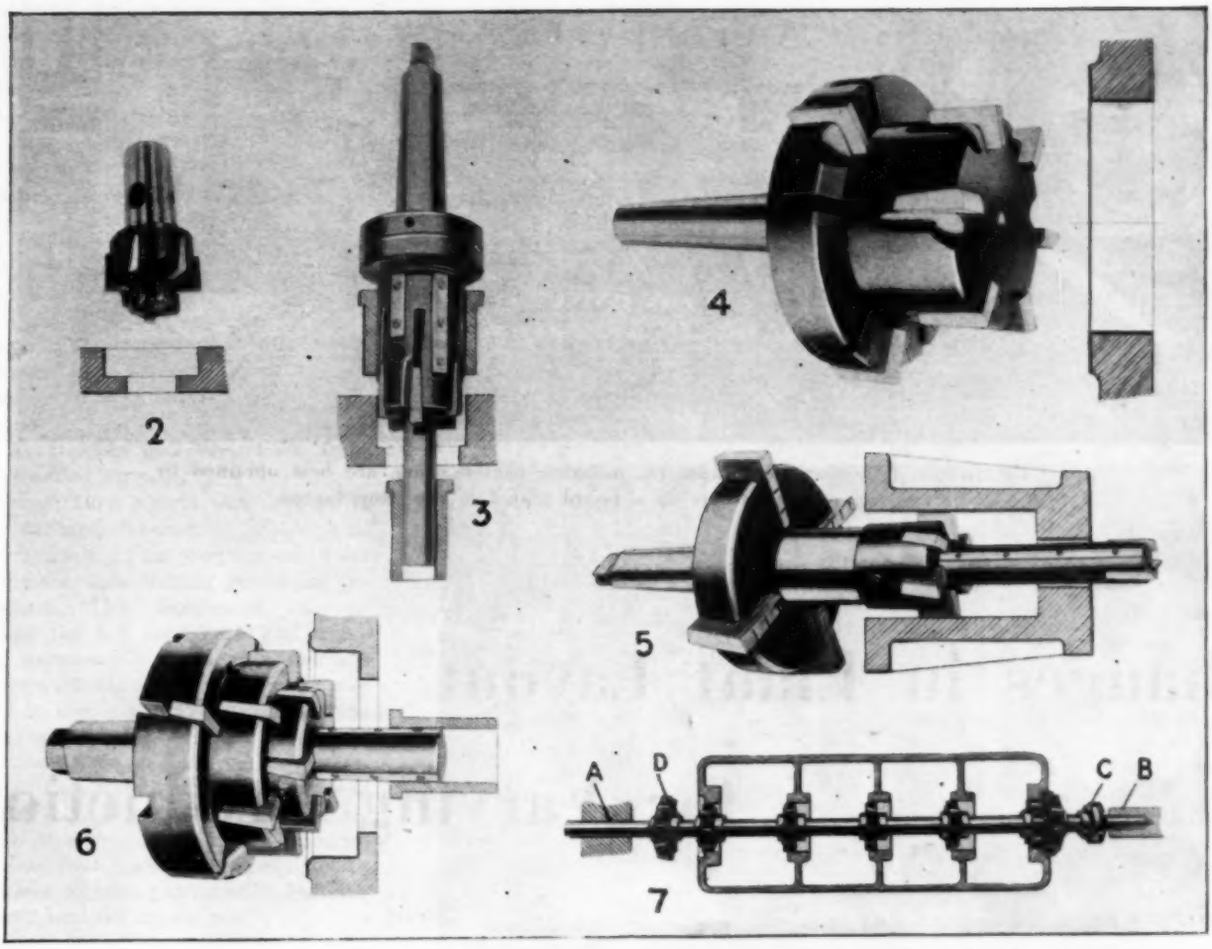


Fig. 1—A pilot, integral with the body, rigidly guides this combination tool through the boring cut and steadies it while facing

Adequate chip clearance demands much thought in combination tools. Where a considerable amount of chips is produced, means must be provided for their removal. This is one of the factors that often prevent combination tools from being used to their limit.

A further refinement of the double-boring tool is illustrated in Fig. 3. It is guided on both sides of the work. The forward pilot runs in a jig bushing underneath, while pilot strips, ground to a diameter slightly larger than the cutter, are behind or above the cutting blades. Adjustable stop collars that strike the top of the upper guide bushing permit the tool to bore to just the right depth. Because of the double piloting and positive stop, accurate work is possible.

Nearly every bored hole has a finished boss at one end or the other. There is no reason why this face should not be cleaned up when rough boring. Fig. 4 shows a combination boring and facing head for this dual operation, using a set of boring blades followed by a facing tool. It is highly desirable to have the boring head out of the cut when the facer starts to work. Facing is an arduous operation, particularly at its start, and if there is chattering, it should not be transmitted on to the bore. The blades in the tools shown are set integrally in the same body. Note that the facer has only half as



A group of combination tools: Fig. 2—Double boring tool; Fig. 3—Double boring tool with pilot; Fig. 4—Boring and facing head; Fig. 5—Double boring and facing tool with pilot; Fig. 6—Boring, facing and chamfering tool; Fig. 7—Boring bar set-up

many blades as the boring head. A more desirable tool would be along the design as shown in Fig. 1.

Quite an intricate tool for finishing a variety of surfaces is shown in Fig. 5. The small cored hole is bored by the boring tools on the front end of the tool. Piloting strips in back of these blades, running in the freshly bored hole, serve to guide the tool for boring the larger and somewhat longer hole. The wide flanged face is cleaned off by the set of facing blades. All of the tools are spaced to one another so that each diameter is bored in the proper sequence for effective operation.

Another elaborate finishing tool is pictured in Fig. 6; here five surfaces are finished at one crack. Not only are two diameters and two surfaces faced, but two blades for chamfering are included. Each set of blades is adjustable to the other. They can be reset and reground to diameter and length when worn. Such compact and rigid tools simplify the set-up.

Transmission or gear cases of large machinery are machined with a boring bar set-up such as shown in Fig. 7. While one set of tools is working, another is being set up by threading the bar and heads together. When brought to the horizontal boring mill, the boring bar is fitted in an outboard bearing *A* and hooked up to the spindle *B* by drive arbor *C*. The boring head *D* back faces counterbore on left end after all other bores are finished. This tooling arrangement insures that each bore will be accurately machined and in alignment. *(To be continued)*

Removing Broken Studs *Discussion*

FORREST L. JOHNSON

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My practical experience with the method recommended by Fred F. Pindar in an article under the title given above (*AM*—Vol. 77, page 216) leads me to suggest that the same method can be used for removing broken taps. If shims about 1/16 in. thick are placed under the washer before welding, removing them after welding will give the necessary clearance to loosen and back out the broken piece of the tap by rotating the lever backward and forward.

A Handy Holder for Boring Tools—*Discussion*

JAMES MCINTOSH

The article by H. H. Henson (*AM* Vol. 77, page 123) shows a holder for boring tools. The writer devised a base to accommodate two sizes of boring bars and square them with the slide face, using a cast iron base with a tongue to fit the bolt slot. The top of the base was machined to provide two V-slots for two standard bar sizes. One control bolt hole held down the cap and fastened the base to the slide.

For a larger lathe the use of two bolts to hold down the tool-bars and holder base could be made to suit the size of bars used. As a matter of fact one size hole and suitable binding means would suit any special job and be a definite register as to center height.

For the fullest utilization of equipment, machine combinations are best obtained by arranging paper cut-outs on a board scaled to the shop layout

Changes in Plant Layout for Varying Production

R. A. FINTZ
Engineer, White Motor Company

Better production control, improved supervision, reduced material handling and lower costs are among the rewards of good equipment arrangement. But many variables must be weighed to achieve the most advantageous layout

IN THE arrangement of plant equipment there are, generally speaking, two methods open to the manufacturer:

1. Segregation or grouping of machinery according to class of work.
2. The assignment to each group of the equipment required for the complete manufacture of an assembled unit arranged scientifically in sequence of operation.

Which of these two arrangements is the more economical depends upon the type and variety of the products to be manufactured. In some manufacturing plants, the former method may lend itself better than the latter, and in others, the contrary is true. Each method has its advantages and its disadvantages which must be remembered in deciding the method to be employed.

For the first method, which groups the machines according to type, the advantages may be summarized as follows:

1. Higher degree of flexibility in manufacturing capacity.
2. Maximum machine activity.
3. Minimum of duplication of equipment.

Disadvantages

1. Increased handling of work.
2. Necessity for process inspection between departments or groups.
3. Setting up a system of controlling production and coordinating the efforts of each department or group.

For the second scheme of arrangements which groups the equipment required for the complete manufacture of a product within one department, the advantages may be summarized as follows:

1. Ease of production and schedule control.
2. Elimination of departmental difficulties by having the entire manufacturing process on each product under centralized supervision.
2. High degree of efficiency by specializing the efforts of each operator.

Disadvantages

1. Higher investment in plant facilities.
2. Minimum machine activity, particularly during dull times.
3. Maximum duplication of equipment.

The latter method is particularly adaptable to work which can be divided into many elements and where each element can be performed by a separate workman. Under this system in production shops, an ordinary laborer can be taught in a few hours to fill any missing link in the long chain of production. The individual workman does one part of a job over and over again. Logically, he does it well, if not better, than a man who has to spread himself over many jobs.

At White Motor Company, because of a great variety of parts that must be

Presented at the conference on "Re-Engineering for Economical Manufacture," Case School of Applied Science, Cleveland, Ohio, on May 12, 1933.

manufactured and varying production schedules, we naturally practice both methods. There are, of course, some departures therefrom in the case of products manufactured in small quantities and where, in our judgment, a different arrangement is more economical.

In modern manufacturing, overhead costs are important, and if there is one item above another that increases overhead, it is the improper routing of the work through the plant. The manner in which the work is routed through the shop is influenced by the arrangement of the equipment within the shop. The modern plan is to have the work flow through the plant in as nearly a straight line as possible for every back track means added expense.

A short time ago it was decided to make the axle department 100 per cent self-contained. This program called for moving the axle housing machining department. This department was expanding the last few years, and it became necessary to add new machine tool equipment. This equipment was added in a general way depending upon the space available, and as a result, the operations were no longer in proper sequence and considerable trucking was necessary. After a survey of the sequence of operations, a strictly progressive line was made with about six to eight feet between machines for banking of stock between operations.

Efficiency Increased

With this new arrangement of equipment and each man working individually as before, the efficiency of operation rose on an average of 12 per cent. The objection to this line was that the shop layout did not allow sufficient space for stock. With the view of overcoming this objection, it was decided to group the line and have each operator share equally from the housing production as a whole. With this cooperative arrangement, the efficiency of operation per man was further increased more than 20 per cent with a request that we place machines closer together, which we did. This illustrates how production may be increased with available facilities by rearrangement of machines without investment in new machine tools or additional tooling.

Many reasons undoubtedly could be advanced by the executives of some shops why they do not discard their old machine tools and replace them with machines having higher productivity and why they are content with improvised tooling methods for any particular job, but there is no good reason under any circumstances why the machinery should not be arranged to obtain the highest possible operating efficiency no matter what the nature or condition of the machine tools or tooling employed. The proper arrangement of the equipment in any plant is the least expensive way of increasing production, and the effort involved will be paid for many times over in increased efficiency of operation.

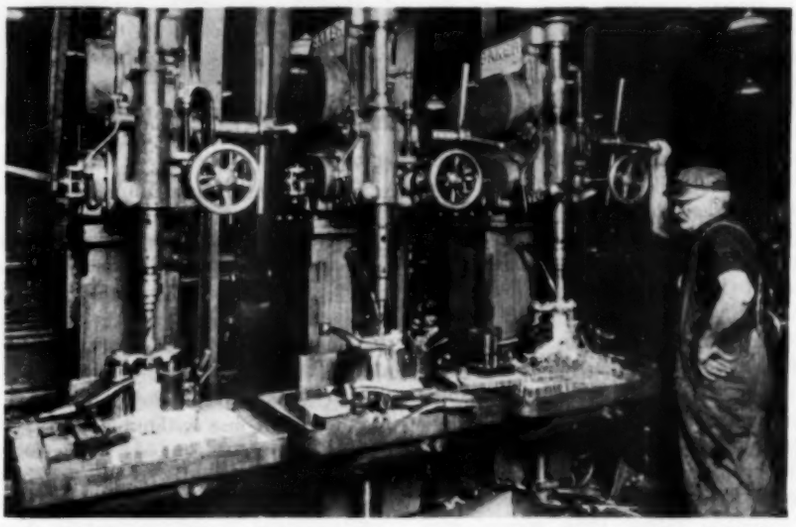
In keeping up with changes in design of the product or changes in manufacturing methods, the rearrangement of equipment in a large plant having some 2,500 machine tools is almost an everyday function. To provide a better means of manufacturing and not to relocate the machines is only doing half the job, and in some cases, the benefits anticipated by the improvement in manufacturing method may be lost by improper location of the equipment involved.

The location of departments also plays an important part in reducing manufacturing costs. An important thing to remember is that in no phase of manufacturing are there greater possibilities for substantial savings than in the process of moving materials from machine to machine or from one department to another.

These problems can often be worked out by means of some kind of a conveyor, either gravity or power. This, of course, is costly from the standpoint of initial investment, and because of uncertainties, one may be just as reluctant to install such a system as he would be to replace his machine tools with those capable of higher productivity. The ideal situation, however, when a plant has a number of different departments is that they be located and coordinated so as to reduce the problem of material handling to a minimum.

At White Motor we have departments so arranged as to reduce the movement of raw and finished materials to a minimum. The departments are also practically self-contained according to major units, such as engine division, axle division, and transmission division. Under the system, each department performs practically all classes of work except heat-treating and other special operations such as plating and polishing, which departments are centrally located and concentrated. The one other special department is the screw machine department which makes all screw production and kindred work for the entire organization.

Not so long ago we also had what we called a grinding department. This department did practically all the grinding for the entire organization. This set-up prevented every department from performing all the successive operations on any part requiring grinding which meant considerable trucking of parts. This department was finally broken up and the machinery distributed to other departments according to their particular needs.



Time required for the longest operation, as balanced against added operations, determines the number of machines an operator can run

Progressive Machining

Despite the great variety of models which we manufacture and our varying production schedules, we have machine lines arranged for progressive straight-line machining according to sequence of operation with carefully worked out material handling facilities. Lines for progressive machining of such essential parts as cylinder blocks, crankcases, crankshafts, connecting rods, pistons, and axle housings stand out and are apparent to the casual observer.

In order not to be overburdened with special purpose machine tools and tooling for those parts, adaptability rather than specialty is always the watchword, but at the same time, the equipment

is kept up with latest methods consistent with production requirements. In a general consideration of the selection of machine tools we always try to decide on the correct place for a standard or universal type of machine as compared with a special or multi-operation type of machine. Today with lower production schedules and constantly changing models, we do not find ourselves embarrassed with many special-purpose machine tools and tool equipment.

In dealing with multi-purpose parts or parts which are reasonably sure to remain stable, the latest and best methods of manufacturing are employed. The economics of the situation, however, always govern and if new machines are needed or if new developments of any value are made, these machines are purchased.

Where progressive machine lines are employed, the arrangement of the equipment and the nature of the tooling is such that the utilization of that line is multi-purpose insofar as possible. This policy reduces need for reengineering to meet present production schedules to a minimum if not entirely eliminating them.

For instance, we make six sizes of standard pistons ranging from 3½ to 4⅝ in. in diameter. One machine line, some ten machines in all, serves for all sizes. Individual chutes are used for moving the work from machine to machine. All of the machines except one are standard rather than special and could be used anywhere in the shop if substitution were desired.

For cylinder machining, we have three distinct machine lines all converging at the end of machining operations for a washing operation, then continuing on down one common conveyor line for subassembly operations, final reaming and honing of cylinders and again coming back through the same washing machine.

Cylinder blocks and crankcases which have not yet reached a point to warrant separate progressive machine lines are machined by a group of standard machines located as conveniently as possible with sufficient space around them for banking the work between operations.

Chassis Erection

In no phase of manufacture at The White Motor Company is flexibility more necessary than in the process of chassis erection. We manufacture 30 current models of trucks and buses ranging from a gross weight of 8,500 to 32,000 lb. or a payload from 1¼ to 9 tons. This complexity of models is run over one power assembly line. At first glance, this may be considered impossible or at best complex. Quite the contrary.

Before modernizing the sheet metal department, punch presses had overhead belt drives and inadequate working space

To illustrate, assuming the power chain is moving at 3 ft. per minute and the standard of earning is 60 cents per hour on the class of work with 10 men working on this section of the line. This means that the men on the line as a group must earn 10 cents per minute or 3⅓ cents for every foot of chain travel. With this as a basis, any model can be run over this line without confusion by merely spacing the chassis at the proper distance to keep the men in their respective zones.

For example, suppose a certain chassis cost, say one dollar to assemble. All such chassis therefore should be placed on the line 30 ft. apart from the front of one chassis to the front of the one following. For a chassis costing two dollars to assemble the spacing obviously should be 60 ft. apart. In other words, the cost of the job divided by the money per foot is the distance at which the chassis should be spaced on the line.

A contributing factor to the success and efficiency of this line is the stockroom which is located adjacent to the chassis assembly. This stockroom carries all stock pertinent to chassis erection and is charged with the responsibility of serving the line with the stock far enough in advance of actual requirement on the assembly line.

Unit assemblies such as axle units, steering stem units, motor units and cowls, are assembled in close proximity to the chassis erection line and delivered to the point of application to the chassis unit. With this system and careful planning of materials used in erection of chassis, all the different models can be run over a single line with the fullest utilization of equipment and effort which would otherwise have to be duplicated to say nothing of the savings in floor space which is also important.

Unit Assembly

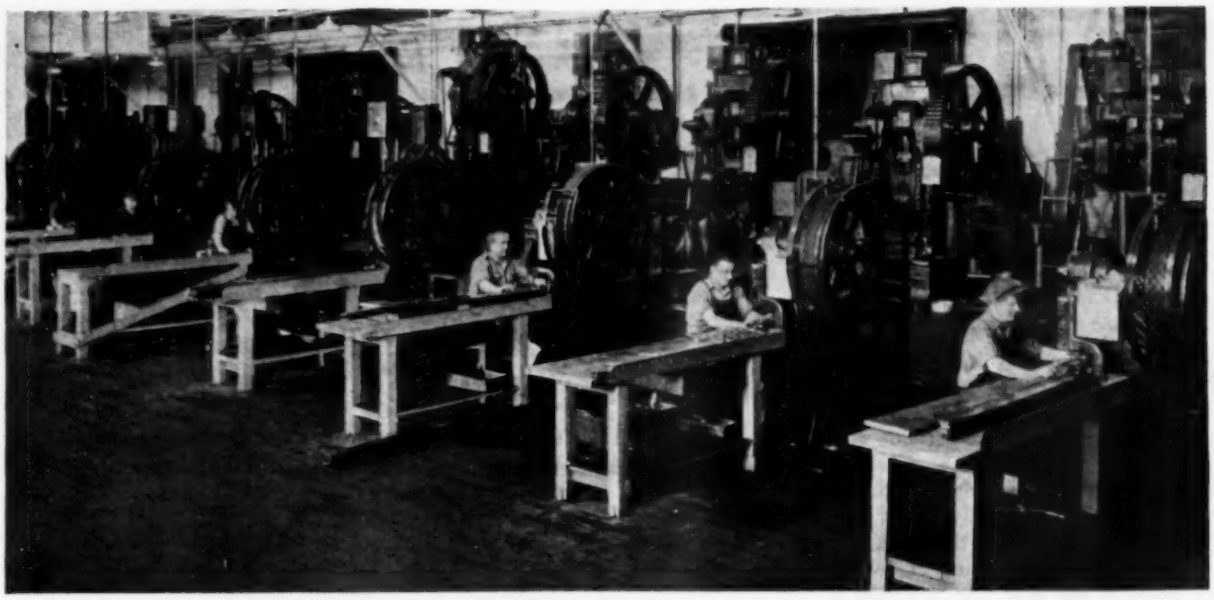
The assembly of the motor, axle and transmission is handled much the same as the chassis erection. The stockroom is adjacent to the assembly line which carries all the stock pertinent to the respective unit and is charged with the responsibility of serving the same to the line at the proper point of application.

Subassemblies for the respective units are coordinated with major assembly units. These lines have all been placed carefully with the view of flexibility for all models and utilization of equipment to the maximum degree.

Combining Operations

When production was the first consideration and all available machines were loaded to capacity, the operation of more than one unlike machine by the same operator was a rare exception. As production dropped and we found ourselves with excess machinery of all description, an economy program was inaugurated. A study of operations was made by the engineering department to see what operations, if any, on any part could be combined and performed by the one operator on different machines simultaneously. To put this into effect, the necessary machines were relocated in combination groups for the operator's convenience. Many such combinations were made throughout the plant, and the results were gratifying.

This procedure results not only in savings in direct labor costs, but eliminates extra handling of the work, reduces the operation list to the least possible number, eliminates extra tool set-up cards and other records, and reduces loss of time between operations, thus accelerating the completion cycle time.



After arranging and motorizing, the sheet metal department presents a picture of orderliness and efficiency

Often, particularly in progressive machine lines, such as the cylinder line, more than one machine is operated by one operator either simultaneously or successively. The purpose of this is to balance operations. When the machines are operated successively for the purpose of balancing the line and keeping the work flowing, the work involved is generally that class where it is necessary for the workman to direct and control the cutting tool by hand as distinguished from an operation done entirely by a machine automatically controlled.

Elemental time study of each operation plays an important part in combining machining operations. There is no guesswork about it; all is based on the actual time required. The operator's class and rate is established accordingly and finds favor with the men.

Volume Influences Combinations

Many combinations made recently with the view of economy could not, however, be made in normal times when each machine was manned by a separate workman to meet production requirements of that day without additional equipment. For that reason, if and when that day returns, many present-day combinations will undoubtedly be broken up to release the machinery for individual tasks. The reason for this is obvious. For instance, suppose we have at present a combination of milling, taking three minutes to perform, and with that operation we have combined, say a one-minute drilling operation. We have then a saving of one minute. The two minutes of idle machine time can easily be spared today, but in normal times this 5½ hours per day idle time may be more gainfully employed on general purpose drill press work, therefore, justifying the breaking up of the combinations unless by analyses additional machinery would prove profitable.

While practically all of the machine tools purchased since 1923 are equipped and operated with individual motors, the majority are still operated from line shafts.

There are many arguments for and against group drive, but production, layout of machinery and many other factors should be considered in determining which method of drive should be used. Furthermore, the efficient method used today may be inefficient tomorrow because of some change in one of the many factors deciding the type of drive.

During normal times, all motors were fully loaded, which resulted in good power factor and consequent reduction of power costs. However, during the low production a line shaft driven by a 50-hp. motor was driving only a few machines. Consequently the motor was underloaded, the power factor dropped and power costs increased.

Proper Lineshaft Grouping Reduces Cost

To overcome this condition some re-engineering was required which, when completed, justified itself by a reduction in power costs. This was accomplished in our regular production departments by cutting off the motor driving one line shaft and driving the shaft by belting to the next line shaft. The same result was accomplished in other cases by substituting a smaller motor for the lightly loaded large motor. In our non-current department where the machines are for the most part arranged according to type, it was conceived that if we had one of each kind or type of machine grouped under one lineshaft we could take care of all the production requirements without running the whole department.

This was done, and the move undoubtedly paid for itself many times over again. This group of machines also comes in handy when the department is called on, as it often is, to perform some rush job at times other than during the regular working hours.

Power Is Saved

Another factor to be considered in regrouping machines and changing drives is the saving in power consumption. A line shaft driving only three machines out of a large group may require say 25 hp. divided into 15 hp. for the machines and 10 hp. for line shaft losses.

A regrouping would perhaps require a 20 hp. motor, the same 15 hp. being used for the machines plus only 5 hp. line shaft loss. Fitting a motor to the job results in an additional power saving since in the first case the motor efficiency at half load would be approximately 67 per cent, and in the second case would be approximately 90 per cent. Calculation would show in the first case a 37½-hp. input is required and in the second case a 22-hp. input or a total saving of 15½ hp.

In any plant where machines are being constantly rearranged to maintain maximum operating efficiency under any circumstances, the efficiency of the transmission equipment if not closely watched may become greatly impaired. Inadvertently, this factor may be overlooked during good times unless it gets out of balance so badly that it would be apparent to any casual observer.

Helical Gear Addenda

V. LEHEL
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A graphical solution is given for determining the limits of long and short addenda helical gears

WHEN generating involute teeth, interference results if the number of teeth in the gear to be cut is below a certain limit. To avoid interference in such cases, without employing special tools, it is a generally accepted practice to withdraw the tool a certain amount radially from the center of the gear. Then the pitch line of the tool will not be tangent to the pitch circle of the gear, but will pass it at a distance K, Fig. 1, whereby the addendum of the gear will be increased and the dedendum shortened.

It is of interest for the gear manufacturer to know the minimum increase of the addendum necessary to avoid interference. For machine tools working with cutters having essentially the profile of a rack, such as hobbing tools or the rack-tool of the Maag or Sunderland machines, the amount of this minimum increase of the addendum for a spur gear of unit diametral pitch is defined by the well known formula:

$$k = f \times \left(1 - \frac{T}{T_o}\right) \quad \ldots\ldots\ldots\ldots (1)$$

where:

k = addendum increase for unit diametral pitch, and called in the following "unit correction,"

F = addendum factor of the tool $\left(\text{addendum} = \frac{F}{P}\right)$. By "addendum" of the tool we mean that straight-sided part of the tooth of the tool denoted a Fig. 2 which generates the dedendum profile of the teeth,

P = diametral pitch,

T = number of teeth in the gear to be cut,

T_o = minimum number of teeth in a gear having no interference from a rack of a pressure angle ψ. This T_o may be calculated from the formula:

$$T_o = \frac{2F}{\sin^2 \psi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

For any gear of diametral pitch P, the total amount of addendum increase K, is inversely proportional to P.

That is:

$$K = \frac{k}{P} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

With a given set of tools, F and ψ are defined, and the corrections (addendum

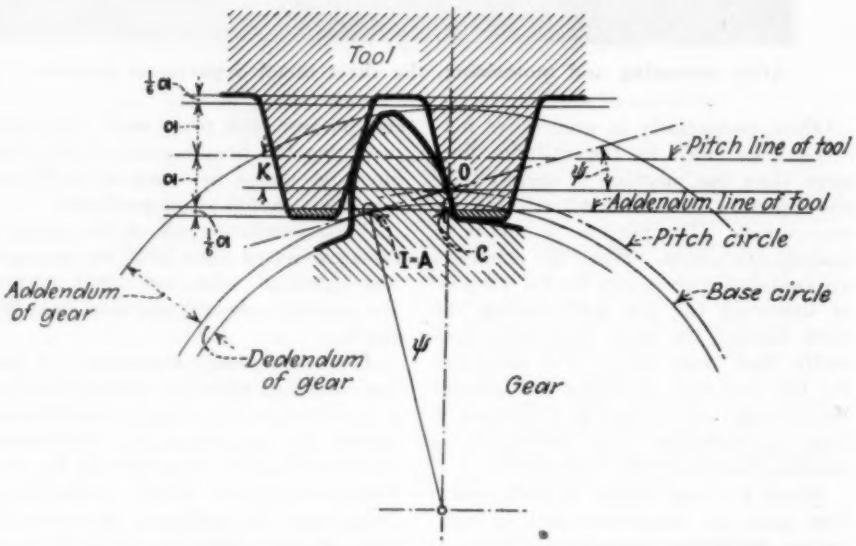

Fig. 1—In cutting long and short addendum teeth, the pitch line of the cutter is moved out of tangency with the pitch line of the gear

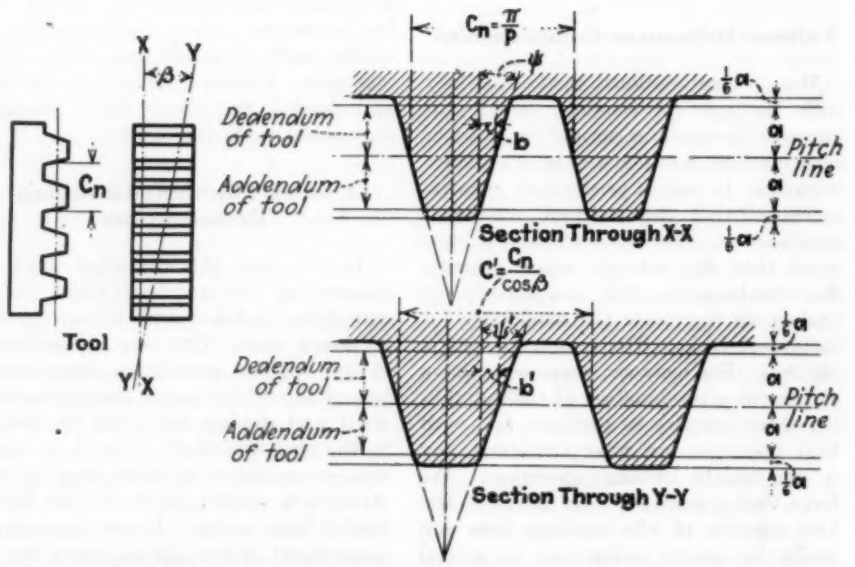

Fig. 2—Tooth dimensions for a helical gear are greater in the plane of rotation than in a plane normal to the teeth

increases) may be calculated for any number of teeth and for any diametral pitch by Formulas 1, 2 and 3.

For standard spur gears of unit addendum depth, these calculations take little time to make, even without referring to tables or graphs. Circumstances become more complicated, however, in the case of helical gears. In cutting helical gears either with a hob or a rack tool, the normal pitch C_N of the tool remains the same with any helix angle, but the pitch C' of the gear in the plane of rotation varies with the helix angle β as seen in Fig. 3. The circular pitch in the plane of rotation:

$$C' = \frac{C_N}{\cos \beta}$$

and, if P_N denotes the normal diametral pitch of the rack, and P' the diametral pitch of the gear in the plane of rotation:

$$P' = P_N \cos \beta$$

Any section of a helical gear in a plane of rotation may be regarded as an infinitely narrow spur gear, meshing with a rack represented by section Y-Y of the tool, Fig. 2. Comparing section Y-Y with section X-X of the tool, it will appear that all dimensions in the direction of the pitch line have increased in the same ratio as the pitch has increased. Hence they will be $\frac{1}{\cos\beta}$ times greater than in a perpendicular section of the tool such as X-X. Consequently the inclination of the rack-tooth profiles changes in the plane of rotation, and the pressure angle ψ will be increased to ψ', inasmuch as:

$$\frac{b}{a} = \tan \psi \quad \text{and} \quad \frac{b'}{a} = \tan \psi'$$

As the dimensions in the direction of the pitch line have increased in the proportion $\frac{1}{\cos\beta}$, b' will be:

$$b' = \frac{b}{\cos \beta}$$

and the new pressure angle ψ' may be obtained from the formula:

$$\tan \psi' = \frac{\tan \psi}{\cos \beta}$$

The circular and the diametral pitch are changed, while the addendum a remains the same; also the addendum factor F' will be different from F:

$$F' = aP' = aP_N \cos \beta = F \cos \beta$$

Because of these changes, the minimum number of teeth T_o of a helical gear, free from interference from the generating rack, will be expressed by the formula:

$$T_o' = \frac{2F'}{\sin^2 \psi'} = \frac{2F \cos \beta}{\sin^2 \psi'} \quad \ldots\ldots\ldots (4)$$

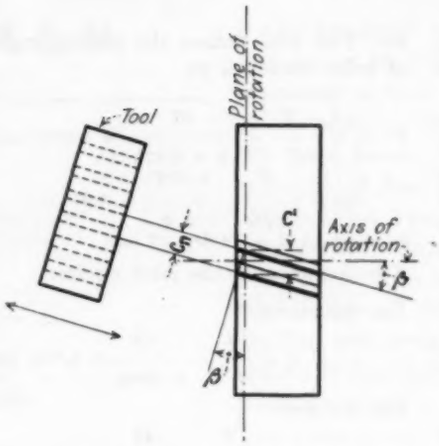

Fig. 3—In cutting a helical gear, the normal pitch is independent of the helix angle but the pitch in the plane of rotation varies with the helix

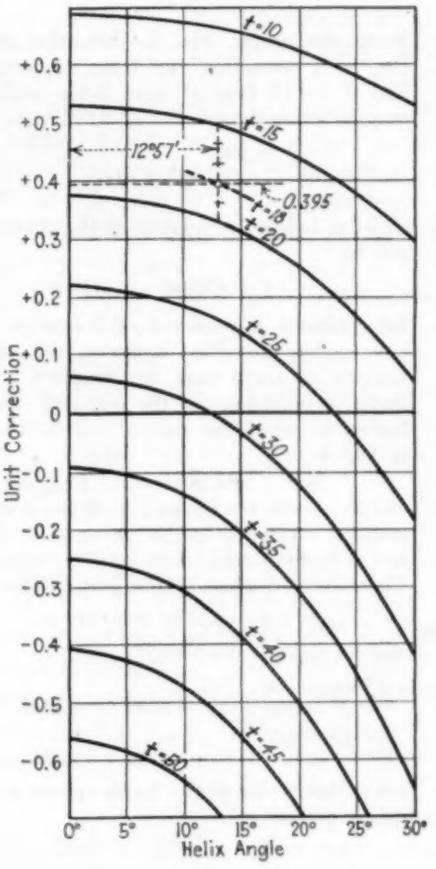

Fig. 4—The minimum unit correction necessary to avoid interference and the permissible negative correction are shown for a tool pressure angle of 14½ deg. and an addendum factor of unity

and the "unit correction" will be:

$$k' = F'\left(1 - \frac{T}{T_o}\right) = F \cos \beta \left(1 - \frac{T}{T_o'}\right)$$

For tools with unit addendum and dedendum depths ($F = 1$):

$$k' = \cos \beta \left(1 - \frac{T}{T_o'}\right)$$

The diametral pitch of the gear in the plane of rotation being P', the total amount of addendum increase will be:

$$K' = \frac{k'}{P'} = \frac{k'}{P_N \cos \beta} = \frac{1}{P_N}\left(1 - \frac{T}{T_o'}\right)$$

From this formula we shall call the value $\left(1 - \frac{T}{T_o'}\right)$ the "unit correction" for helical gears, and in the following, it will be denoted k_H. Then:

$$k_H = 1 - \frac{T}{T_o'} \quad \ldots\ldots\ldots\ldots (5)$$

As the helix angle is different in almost every case, it is rather troublesome to calculate separately from the above formula the necessary minimum of addendum increase for every individual case. Calculations may be simplified to a great extent by representing Formula 5 graphically, as it is shown in Fig. 4, which is an example of such a graph for a tool pressure angle of 14½ deg. and a tool addendum factor F = 1. The necessary "minimum unit corrections" for tooth numbers of 10, 15, 20, 25, 30, 35, 40, 45 and 50 are plotted against the helix angle.

With a greater number of teeth in the gear, it is also possible to decrease the addendum and increase the dedendum of the teeth without causing interference. The amount of this "negative correction" permissible without interference is also indicated in Fig. 4.

If two spur gears are working together, say, a pinion of 16 teeth and a gear of 50 teeth, and if a pressure angle of 14½ deg. is assumed, the pinion will require an addendum increase of:

$$k_1 = 1 - \frac{t}{t_o} = 1 - \frac{16}{32} = +0.5$$

while no addendum increase is necessary in the gear. If only the addendum of the pinion were increased, however, the distance of gear centers could not remain normal but would also have to be increased. This may be avoided, however, in a majority of cases by decreasing the addendum of the gear by the same amount as the pinion's addendum was increased, whereby the pinion's teeth will gain as much in thickness at the pitch circle as the gear's teeth have become thinner, and the sum of both tooth thicknesses will remain unchanged

and will be equal to the circular pitch, maintaining correct meshing without backlash.

This is, of course, provided the gears are cut with a rack or hobbing tool. A correction of tooth thickness when gears are cut with a generating gear-shaped tool, as in the Fellows' machines, was described in Sam Trimbath's article (*AM*—Vol. 76, page 296). In our example, for instance, an addendum decrease:

$$k_2 = 1 - \frac{T}{T_o} = 1 - \frac{50}{32} = -0.563$$

would be permissible without causing interference in the gear, so it is permissible to increase the addendum of the pinion by 0.5 and decrease the addendum of the wheel also by 0.5, whereby the sum of the corrections in the pair will be zero, and the center distance E remains normal. That is:

$$E = \frac{t + T}{2P}$$

It is always possible to correct the gears in the manner before mentioned when:

$$t + T \geqq 2T_o$$

It is not objectionable, however, to permit a certain amount of interference, because, to a certain degree, this will not appreciably weaken the teeth or shorten the angle of action, while on the other hand, the sum of the number of teeth in gear and pinion can be reduced to less than $2T_o$. In this case, we use only a certain part of the above calculated increase in the pinion, and we may also permit a little more addendum decrease in the wheel than indicated by the above formulas or in the graphs. To maintain a normal center distance it is important only that the sum of the corrections in wheel and pinion shall be zero. Thus it is evident, that a not entirely precise reading of the figures from the graphs does not influence in the least the perfect meshing of the gears, provided the positive and negative corrections in pinion and wheel are exactly equal.

The following example will explain the use of such graphs. Let the wheel have $T = 49$, and the pinion $t = 18$ teeth. Assume that we have a cutting tool of $\psi = 14\frac{1}{2}$ deg. pressure angle, and of $P_N = 5$ diametral pitch. As the first approximation, we may assume a helix angle of 12 deg. With this the diametral pitch in the plane of rotation is:

$$P = P_N \cos \beta = 5 \cos 12 \text{ deg.} = 4.89$$

and the center distance:

$$E = \frac{t + T}{2P'} = \frac{18 + 19}{2 \times 4.89} = 6.85 \text{ in.}$$

Since we want to have the distance of centers a round figure, we may take the next round number: $6\frac{7}{8} = 6.875$ in. This now defines the precise angle of helix, inasmuch as:

$$P' = \frac{t + T}{2E} = \frac{67}{2 \times 6.875} = 4.8727 \text{ and}$$

$$\cos \beta = \frac{P'}{P_N} = \frac{4.8727}{5.0} = 0.97454$$

from which $\beta = 12$ deg. 57 min.

The diameters of the pitch circles:

For the pinion:

$$d = \frac{t}{P'} = \frac{18}{4.8727} = 3.694 \text{ in.}$$

For the gear:

$$D = \frac{T}{P'} = \frac{49}{4.8727} = 10.056 \text{ in.}$$

In standard gears of 5 diametral pitch, the addendum is $a = \frac{1}{5}$ in. To avoid interference, this shall be increased in the pinion with

$$K = \frac{k_H}{P_N}$$

From the graph, Fig. 4, the value of the "unit correction" for $t = 18$ teeth and $\beta = 12$ deg. 57 mm. helix angle may be interpolated: $k_H = 0.395$, thus:

$$K = \frac{0.395}{5} = 0.0790 \text{ in.}$$

and the definite addendum of the pinion will be:

$$A_{pin} = 0.2 + 0.0790 = 0.2790 \text{ in.}$$

Interpolation is rendered easy and precise by the fact that a curve for any number of teeth may be obtained by linear subdivision of the vertical distances between the curves represented in Fig. 4.

As $t + T > 64$, with $\psi = 14\frac{1}{2}$ deg. and $T_o = 32$, the addendum of the gear may be shortened by the same amount as the pinion's addendum was increased. Then the addendum of the gear will be:

$$A_{gear} = 0.2 - 0.0790 = 0.1210 \text{ in.}$$

and the outside diameters:

Of the pinion:
$d_o = 3.694 + 2 \times 0.2790 = 4.2520$ in.

Of the wheel:
$D_o = 10.056 + 2 \times 0.1218 = 10.2980$ in.

while the depth of the tooth spaces remains normal.

Doubtful Economy of Homemade Fixtures

H. D. ANDERSON

On account of limited appropriations for shop equipment, the master mechanics and shop superintendents of many railroads are making their own jigs, fixtures and shop appliances.

At one outlying point where a hydraulic press was needed, a "whisky" jack was mounted in a substantial frame and used as a press. At another point, a hoist was needed for fitting driving boxes. An air cylinder was arranged with a suitable piston and piston rod, the rod having a hook on the outer end for attaching a sling. At still another point, the back shop of a large road, scrap air-reservoirs were set up on legs, doorways cut out and doors fitted, and were used as lockers for clothes and tools. Some were mounted on wheels and used as portable tool boxes. One of the larger reservoirs was given to the truck gang to be used as a stationary box for tools that were too bulky to go in ordinary tool boxes.

While those who make their own appliances and fixtures may avoid spending money for manufactured articles at the time, they are out the cost of the labor required to make them, and there is no doubt that the practice is poor economy in the long run. For example, take the piston-type air hoist, which is common in many of the older railroad shops. Hoists of this type are rather violent in action and are hard to control accurately. Some of them have no doubt contributed to many accidents, as their action under load is rather jerky. Nearly all homemade devices using compressed air are wasteful of air, and it is not "free air" by any means.

The use of old reservoirs as tool lockers does not make a neat-appearing shop. Of irregular sizes, and cylindrical in shape, they do not fit together well and are stood around in odd corners. This practice might be O.K. in an outlying roundhouse, but would not look well in a division back-shop. The manufacturers of shop equipment have the advantages of the economies afforded by mass production; their products are designed by engineers who are familiar with all other devices used for the same purpose; and the articles themselves represent the maximum of experience and study.

As an example, note the improvements in the methods of machining driving boxes and shoes and wedges brought about by the use of specially designed fixtures furnished with one make of draw-cut shaper. Fifteen years ago, every railroad shop had various homemade fixtures for machining some parts of engines. Crown brasses were often turned in a lathe, the ends being clamped between heavy washers fitted on a mandrel. Where homemade fixtures for machining driving boxes and shoes and wedges have been replaced by modern equipment, the machining cost has been reduced fully 75 per cent. Although homemade fixtures may answer the purpose for which they are intended, when the time element is considered they compare very unfavorably with manufactured devices.

EDITORIALS

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EDITORS

Code Coordination

Now that the first of the big industry trade practice codes has been submitted and hearings have started, code makers can begin to gain some conception of what is expected by NIRA, to use the initials by which Gen. Johnson's organization is commonly designated. At the same time they can see some of the things that will have to be worked out in their own interest.

For example, the honest difference of opinion between textile manufacturers, tire manufacturers that operate their own textile mills, and tire manufacturers that do not, proves definitely the necessity for coordinating labor codes in industry groups that employ the same kinds of labor. As we have pointed out in earlier editorials this factor is a most important one to the metal-working industry. The various trade associations in this field should certainly see to it that this factor is handled satisfactorily, either through a master code for the industry as a whole, or through careful coordination of the various codes worked out by the respective subdivisions of the industry.

In deciding between these alternatives Gen. Johnson's frank statement of policy should be observed. He is interested only in action, not so much in how that action comes about. In other words, he will favor whichever of the two alternatives will result in getting men back to work the quickest.

The action taken at New York last week when a group of representative leaders of the industry met to organize a federation of trade associations with John W. O'Leary as chairman is a big step in the right direction.

Separate Treatments for Our Acute and Chronic Economic Disorders

Encouraging evidence that some clear thinking is being done in the midst of what several correspondents call the Washington "mess" is the separation of the groups dealing with industry control and economic planning. General Johnson has reiterated his conviction that his job, and the job of his staff, is to get men back to work in the emergency that still exists. Under the terms of the law he has two years, or less, if the President so decides, to carry on certain functions; one year for the licensing provision. He has expressed a lack of interest in niceties of definition in the codes to be offered, insisting that they stick to the main issues, better wages, more jobs and enough restraint of bad trade practices to insure the safety of the other two.

Secretary Roper, on the contrary, conceives it to be a part of his job to stimulate business and industrial leaders to look further ahead than the emergency. To that end, with the advice of a picked group of well-known industrialists, he has set up an advisory and planning council for the Department of Commerce. The council met on June 26 and organized by electing an executive committee of eight under the chairmanship of Gerard Swope, and by appointing other committees to study questions directly concerning the Department of Commerce and its foreign and domestic activities, and general business problems.

The latter committees will tackle these problems: general economic research; decentralization of industry; international trade relations; business ethics, unfair competition, standardization, and elimination of wastes of distribution; statistical reporting and uniform accounts for industry. The first of these committees will name an advisory committee of economists.

What will come out of all this no one knows. Perhaps it is just another committee. But the present temper of the public, the chastening effect of industry's recent sad experience, and the caliber of the men on the various subcommittees encourages us to express the pious hope that out of it all will come a plan that will avoid the necessity for another such experiment in industrial control as the one on which the country is embarking with mingled hopes and fears.

Greater Efficiency in Cutting Tools

In the last analysis efficient machining depends on the cutting tool. As long as carbon tools were the only ones available there was no object in designing high-speed machinery. Mushet and high-speed steels gave the opportunity for new designs of machines, making many of the older types obsolete. Stellite and the new tungsten- and tantalum-carbide alloys gave an added impetus to the designer and made even higher speeds possible.

For the immediate future the high-speed steels seem likely to be used in the majority of machining operations. But that does not mean a cessation of improvements, as there are indications that the average high-speed tool is not being used with maximum efficiency. Tests indicate that the present steels can be improved by somewhat different and more careful heat-treatment. Higher heats, held within close temperature ranges, add appreciably to the cutting quality of many tools.

Makers of furnaces and temperature control appa-

ratus have an opportunity to add to tool efficiency and permit the removal of metal at higher speeds and lower costs than ever before. Heat treaters may have to revise their methods. The combination spells progress even with our present steels. And the steel makers are striving, as always, to give us better and better cutting tools.

CHIPS

General Johnson announces names of his assistants, outlines code principles . . . Cotton Textile industry submits first code and hearings begin . . . Secretary Wallace inaugurates cotton production lowering plan . . . Announces limitation of regular expenditures of Department of Agriculture, dropping market news service, and reducing cooperative and experiment station work—and then announces that he has changed his mind . . . Local postage reduced to two cents July 1 . . . Navy will open bids on 16 ships July 16 . . . Secretary Roper announces personnel of committee on long range economic planning . . . Committee meets in Washington, sets up executive committee headed by Gerard Swope . . . Economy laws, effective July 1, start wholesale housecleanings in departmental clerical staffs in Washington . . . Leaf tobacco acreage reduction plan begins to function . . . Secretary Swanson issues naval policy statement calling for full treaty navy . . . Rumor persists that railroads earning interest charges will get substantial equipment loans from government.

German Nazis wipe out the Steel Helmets, or National Party, by absorption . . . Hitler announces end of toleration of other political parties . . . Roosevelt invites world debtors that have made payments to discuss terms individually . . . Omits defaulters for the present . . . Negotiations for sale of Chinese Eastern Railway to Manchukuo begin . . . Moley arrives at London to see what can be done (if anything) to save the economic conference . . . Disarmament Conference adjourns until October 16 . . . France suggests international ship pool . . . Soviets to buy American cotton on R.F.C. loan to exporters . . . Release British engineers, resume trade with England.

Treasury ceases paying interest on deposits created by subscriptions for federal issues . . . New York Clearing House cuts time rate from ½ to ¼ per cent . . . Tax receipts for May indicate wide recovery of trade . . . Ford surplus drops $74,000,000 . . . U. S. deficit for year ending June 30, 1933, approximately $1,750,000,000 . . . Senate committee resumes investigation of private bankers, examines Otto H. Kahn of Kuhn, Loeb & Co., and adjourns until October . . . Kahn urges income tax law revision . . . Dollar drops to record low in foreign exchange as pound approaches old parity . . . Washington believed to be considering some sort of a sliding-scale stabilization arrangement along lines suggested by J. M. Keynes, English economist . . . Hard to see how gold standard countries can hold out much longer against inflation.

General Electric raises wages 5 per cent . . . Payroll of Wahl Co. (pens) doubled . . . Mullins Manufacturing raises wages and salaries 10 per cent, adds 250 men by spreading work . . . National Acme's June business 75 per cent ahead of May . . . Pennsylvania R.R. recalls 600 men on heavy locomotive repair at Columbus, 2,000 at Altoona . . . Elmira Foundry employees working full time, two shifts, at 5 per cent pay increase . . . After discussion with Eastman, railroad coordinator, railroad executives and union leaders agree to continue existing 10 per cent cut until Feb. 15, 1934 . . . Industrial sales of Toledo Scale up 60 per cent in May . . . Lighting fixture manufacturers raise wages 10 per cent . . . Great Lakes Steel adds 1,000 men, $3,000,000 equipment . . . New York Central and Chesapeake & Ohio coordinate passenger service between Detroit, Toledo and Columbus . . . Edward G. Budd Manufacturing has recalled 3,000 men in last eight weeks . . . Shipyard owners protest plan to build huge Pensacola plant with government loan . . . Stromberg-Carlson Telephone raises wages and salaries 12½ per cent . . . Pennsylvania will install air conditioning on all cars running between New York and Philadelphia . . . Brooklyn Rapid Transit orders light-weight five-unit experimental train from Pullman . . . Westinghouse boosts pay 5 per cent.

Secretary Wallace hints at dumping of our surplus wheat if other wheat producing countries don't play ball . . . Russia and Argentina join Canada and U. S. in agreement to restrict wheat acreage . . . Australia expected to come in . . . Secretary Dern and Speaker Rainey go to Chicago to open Lakes-to-Gulf canal link . . . Eastman divides railroads of country into three groups to discuss economies . . . American Manufacturers Export Association announces plan for central bank to finance foreign trade with aid of R.F.C. . . . National Retail Dry Goods Association draws up first retailing code including maximum 48-hour week and minimum wage rates varying with population density . . . Failures decline to October, 1929, level.

Wheat crosses one dollar on crop damage reports and speculative buying . . . Other grains and commodities rise in sympathy . . . Steel output up to 53 per cent . . . Scrap price higher . . . Electrical energy production nearly 11 per cent above 1932, continued rise contrary to usual seasonal trend . . . Wholesale food index rises 5 cents, 19 per cent above 1932 figure . . . Carloadings continue increases . . . Business Week index rises again, now at 66.

Johnson Starts Hearings on Industrial Codes

Washington, D. C.—Characterized by General Hugh S. Johnson, Administrator for Industrial Recovery, as the cornerstone of a structure that "may prove the most momentous social movement ever attempted," hearings opened on the first industrial code on June 27. First to the tape was the cotton textile industry which laid its code on the "partnership table."

The hearings are crowded. In addition to General Johnson, Donald Richberg, chief of the legal division of the Recovery Administration, W. L. Allen, who presided at the hearing, Dr. Alexander Sachs, economists, sponsors of the bill, advisory committees and witnesses, the Assembly Hall in the Commerce Building was packed with attorneys and trade association representatives eager to learn at first hand the procedure to be followed.

At the General's right sat the Industrial Advisory Board, at his left the Labor Advisory Board and in the center behind the presiding group was the Consumers' Advisory Board.

Mr. Allen introduced General Johnson, "whose inspiration has been back of every phase of the National Industrial Recovery Act." General Johnson presented the men about the table and then introduced Mr. Richberg who set forth the procedure.

There will be, said Mr. Richberg, no judicial investigations nor, strictly speaking, legislative investigations, but rather administrative inquiries for the purpose of adequately advising the Administration of the Act of the facts upon which the exercise of authority must be predicated. Since the law lays down no requirements for public hearings "there are no statutory limitations or controls on procedure," and "no representative of a private interest favoring or opposing a code has any legal right to control or direct the presentation of evidence or the procedure of a public hearing." The Deputy Administrator presiding will have full control under the regulations of the Administrator, and it will be his purpose to give everybody interested an "adequate opportunity" for presenting his evidence and suggestions on a code.

Sponsors for codes will be required to present evidence that all requirements regarding codes (Section 3a of the law) are complied with. Objectors to provisions of the code must file in writing their full arguments, oral arguments on other matters may be permitted only by authority of the Deputy Administrator.

There is no objection to representation by attorneys or specialists but under no circumstances will cross examination of any representative by opposing interests be permitted.

Deputy Allen's first day brought out various rulings, one being that sponsors of a code should be allowed to present their cases without hindrance—a ruling that it was necessary to modify when it became evident that if the job was to be gotten through speedily control of evidence presented orally would have to be enforced.

The first hearings demonstrated the soundness of the plan of allowing the interests at stake to present their own selected spokesman as the sponsors, in particular where these were men selected for their clearness of conception and their broad understanding of the application of the new law to their industry.

Another ruling was brought about by the criticism of William D. Anderson, first vice-president of the American Cotton Manufacturers Association, against certain tire makers who own their own plants and who do not wish to be included in the textile code. Mr. Allen ruled that names of companies and individuals should not be brought in unless documentary evidence supporting the charges had previously been filed.

After presentation by the sponsors, the hearings took up the code section by section, and witnesses in each group, industrial, labor and consumer, and special groups were heard on each clause. This set the form of procedure to be followed in general in all hearings on all codes.

The Administration is publishing all codes as soon as they are received officially and with these available it is required that all parties interested shall file written briefs upon receipt of which they will be given a place in the studies made by the Administration or allowed to appear as witnesses.

General Johnson in his press conferences has endeavored to anticipate questions that will arise in the procedure on the methods of submitting codes. He has called attention to the Statement of the President, Bulletin 1, and his own Bulletin 2 which contains many of the answers.

Some of his remarks are to the point in revealing the way the new law will operate:

"Nobody is going to get around the provisions of the law if I can help it. If they do, it will be my fault. But I do not assume or think that industries or companies are going to try . . . I

• INDUSTRIAL REVIEW •

Many machinery builders found June their best month since the end of 1931. Orders for repair parts were strong, supply and small tool business was up, used machines were in greater demand and inquiries for new equipment were more numerous. Enough real orders were booked to cheer up the trade considerably although volume is still very small. Considerable concern has been expressed over the interpretation of the implications in the Industrial Recovery Act regarding modern equipment and its effect on jobs, but the feeling is that reason will prevail.

Chicago reports that A Century of Progress is helping almost every kind of business except the machine tool business but that prospects for the immediate future look good. Milwaukee likewise is expecting an improvement soon. Machinery men there are more optimistic than for many months. In St. Louis small tool and supply business has grown to the point where it is returning a profit, but machine tool orders are confined to single units.

Counter-seasonal increases in motor car sales have improved sentiment in Detroit, and also the tool and supply business. A few machine tool orders have come through and more are in sight. The contract tool shops are beginning to get busy on tools and dies for 1934 models. Cleveland has been watching the rise in steel with satisfaction and machinery people are getting some reflection of it in their own affairs. Cincinnati sources report the general betterment of supply business and some improvement in machinery orders and inquiries.

Pittsburgh supply business is much better and machinery orders have gained a little but not as much as general sentiment. In Philadelphia, New York and New England inquiries are gaining and enough orders have been taken to give distributors high hopes for the fall.

should like to have industry come in with codes covering the largest groups possible, simply because we can thus work faster and get men back to work faster . . . We are going to do our job in a goldfish bowl and every interest will be given its day in court . . . I think the plan to fix minimum wages is entirely practical if we can get everybody to do it, otherwise we shall run into difficulties . . . No maximum prices should be set . . . We are trying to increase purchasing power . . . We are going to ask an armistice on excess capacity until we get this spiral of increased purchasing power started . . . We can and will plead with industry not to increase capacity by new labor saving devices at this time . . . This Administration is not going to be used as a means to force mechanization on any industry."

Close to 100 codes, tentative or carefully completed, have arrived in Washington already as an earnest of the tidal-wave that is to come to the National Industry Recovery Administration. Most have reached the Bureau of Foreign and Domestic Commerce which today is the clearing house and fountain head of advice regarding the mysterious workings of the new law.

Industries are to go into immense groups to start with; the industry breakdown of the Census is now being used, 17 major classifications, although 28 is mentioned. It is expected that 25 to 40 hearings may be going on simultaneously all summer. But Johnson's "five key industries" (textiles, coal, iron and steel, automobiles, petroleum), and the President's ten (mentioned when he signed the bill but not listed) will come first. Johnson says his five account for 70 per cent of the employment of the country.

Contract Shops Under NIRA

Washington.—The place of the small contract shop in the organization of industry under the National Industrial Recovery Administration has not yet been definitely decided, but officials of the NIRA point out that as such shops (employing from one to 25 men, say) enter definitely into competition for labor, and have, in their relations with industry and in competition with one another, many traditional trade practices which may need correction, they will do well to join in the movement. It is pointed out that the new law is a workmen's law, and the classifications of industry are so far as possible through related employment problems. As the contract shop employs the same type of workmen as the manufacturer of metal goods for sale, and often does small manufacturing as well, and as, on the other hand, much of his labor is comparable to repair men and machinists in plants other than metal manufacturing, the owner distinctly has interests that must be protected—as have his workmen.

The Recovery Administration is seeking to help industry to organize itself, and to meet the employment problems which are considered to be of most vital national concern at this time, and while as yet there have been no pronouncements as to who and what groups must organize and submit codes, the invitation is general and is open to all. Later, there may be definite rulings requiring codes from every group, specifically. At present, the broad basic code of the iron and steel group is expected to be heard before the middle of July, and no codes would be expected from minor groups in that industry until the basic code is heard.

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W. L. ALLEN
Consulting Metallurgist
Prof. EARL D. HOWARD
Northwestern University
ARTHUR D. WHITESIDE
President, Dun & Bradstreet
Maj. Gen. C. C. WILLIAMS
Former Chief of Ordinance, U. S. A.
X. M. SIMPSON
Consulting engineer, president, International Chromium Process Corp.
NELSON SLATER
President, S. Slater & Sons, textiles

Industrial Advisory Board

AUSTIN FINCH
President, Thomasville (Ga.) Chair Co.
EDWARD N. HURLEY
Chairman of the board, Hurley Machine Co.
LOUIS KIRSTEIN
Vice-President, William Filene's Sons
ALFRED P. SLOAN
President, General Motors
WALTER C. TEAGLE
Chairman of the board, Standard Oil Co. (N. J.)
GERARD SWOPE
President, General Electric Co.
WILLIAM J. VEREEN
Cotton manufacturer

Labor Advisory Board

Dr. LEO WOLMAN Chairman
Labor economist
JOSEPH FRANKLIN
President, International Boilermakers Union
WILLIAM H. GREEN
President, American Federation of Labor
JOHN FREY
A. F. of L. Metal Trades Department
SIDNEY HILLMAN
President, Amalgamated Clothing Workers
Father FRANCIS HAAS
Catholic Welfare Council
ROSE SCHNEIDERMAN
Secretary, Women's Trade Union League

Consumers' Advisory Board

Mrs. C. C. RUMSEY Chairman
Social worker
Dr. FRANK GRAHAM
President, University of North Carolina
Prof. WILLIAM OGBURN
University of Chicago, economist and statistician
Mrs. JOSEPHUS J. DANIELS
President, Indiana League of Women Voters
Miss BELL SHERWIN
President, National League of Women Voters
Two additional members are yet to be named.

Leaders of Equipment Industries Form Federation of Trade Associations

Three-score leaders of the machinery and allied industries met at the Biltmore in New York on June 23 and 24 to consider common interests and to discuss the extent to which coordination of these interests might be possible. A wide range of industries was represented. A committee of twelve under the chairmanship of George F. Houston, president Baldwin Locomotive Works, brought in a report recommending a federation of trade associations, membership in which would be limited to associations. The report was adopted and John W. O'Leary was elected to head the new organization.

Mr. O'Leary is president of A. J. O'Leary & Sons, makers of drop forgings, vice-chairman of the Central Republic Bank of Chicago, a director of Chicago Great Western R.R., Chicago Railways, Advance Rumely Corp. and Belden Mfg. Co. He is a past-president of the Chamber of Commerce of the U. S., of the National Metal Trades Association, and of the Chicago Association of Commerce.

Among the machine tool builders at the meeting were R. M. Gaylord, F. A. Geier, James E. Gleason, P. E. Bliss, J. B. Doan, E. A. Muller, Paul C. DeWolf and George Rentschler.

A more detailed statement of the objectives and organization is expected.

Malcolm Muir Appointed a Deputy Administrator

Gen. Hugh S. Johnson, administrator of the National Industrial Recovery Act, has announced the appointment of Malcolm Muir of New York as one of his deputies. Mr. Muir's appointment represents a "horizontal" cross-section of industry, due to his intimate acquaintance with the problems of the "capital goods" and machinery groups as chief executive of the McGraw-Hill magazines, and past president of the Associated Business Papers. Mr. Muir is a director of the National Publishers' Association, the American Arbitration Society, the Advisory Board of the Army Ordnance Association for the New York District, and of the Merchants' Association of New York. He has also served recently as a member of the National Committee on Industrial Rehabilitation and chairman of its New York Board. Mr. Muir will divide his time between NIRA work at Washington and his company responsibilities in New York.

Doty Heads A.S.M.E. Slate

Paul Doty, chairman of the board, Minnesota State Board of Registration, was selected by the nominating committee as president of the Society for 1934 at the recent meeting in Chicago. Election will be held by letter ballot closing on September 26. Other nominees presented were:

Vice-presidents:

H. L. Doolittle, designing engineer, Southern California Edison Co.

William L. Batt, president, S.K.F. Industries, Inc.

Ely C. Hutchinson, president, Edge Moor Iron Co.

Elliot H. Whitlock, former research professor, Stevens Institute of Technology.

Managers:

James M. Todd, consulting engineer.

Ernest L. Ohle, professor of mechanical engineering, Washington University.

James A. Hall, professor of mechanical engineering, Brown University.

Engineers Have Successful Week at Chicago

Putting to shame the ordinary three-ring circus for variety of attractions, the score or so of societies participating in Engineering Week at the Century of Progress, June 25-30, covered a lot of ground technically and geographically. The Stevens, the Palmer House, and the Edgewater Beach Hotel all housed some of the delegations.

Of particular interest to metal-working engineers was a paper by Fredrich Schwerd of Hanover, Germany, on "Results of Research Relating to the Theory of Metal-Cutting." Moving pictures and lantern slides brought out new concepts of the action of cutting tools on the work, especially in regard to chip deformation. The paper on "Cemented Carbide Cutting Tools" by Malcolm F. Judkins and William C. Uecker, of the Firth-Sterling Co. already printed in these pages, (*AM*—Vol. 77, pages 326 and 364), was also favorably received.

"Elements of Milling" by Prof. O. W. Boston and C. E. Kraus, of the University of Michigan, added another chapter to an illuminating series. Herbert Isenberger, of St. John X-Ray Service Corp., gave details of a rapid but inexpensive method in his "Recent Progress of X-Ray Inspection of Welds."

Lanahan Heads A.F.A.

At its 37th annual convention, held in Chicago during the week of June 20–23, the American Foundrymen's Association elected Frank J. Lanahan president. Mr Lanahan is president of the Fort Pitt Malleable Iron Co., Davis Brake Beam Co., Fort Pitt Mine Equipment Co., McKees Rocks Trust Co., chairman of the board, Auto Tite Joints Co., member of the board of directors, Warren Foundry & Pipe Corporation and vice-president of Chartiers Trust Co.

Other officers selected are:

Vice-president: Dan M. Avey, editor *The Foundry*.

Directors: T. S. Hammond, president, Whiting Corporation.

R. J. Teetor, general manager, Cadillac Malleable Iron Co.

R. F. Harrington, metallurgist, Hunt-Spiller Manufacturing Co.

J. L. Wick, Jr., president and general manager, Falcon Bronze Co.

Dr. H. Ries, Cornell University.

A.S.T.M. Elects

At the annual meeting of the American Society for Testing Materials, held during Engineering Week at Chicago, the election of the following officers for 1933-34 was announced.

President: T. R. Lawson, Rensselaer Polytechnic Institute

Vice-President: Herman von Schrenk, consulting timber engineer

Members of Executive Committee:

Frank A. Barbour, consulting hydraulic and sanitary engineer

Arno C. Fieldner, chief engineer, Experiment Station Division, U. S. Bureau of Mines.

C. N. Forrest, The Barber Asphalt Co.

J. C. Pearson, director of research, Lehigh Portland Cement Co.

A. E. White, University of Michigan.

Exports of Machinery During May, 1933

	May, 1933	April, 1933	May, 1932
Electrical machinery	$3,109,410	$2,877,083	$3,771,051
Power generating machinery (except electric and automotive)	210,715	239,648	816,266
Construction machinery	187,363	276,876	635,138
Mining, well and pumping equipment	890,028	801,005	895,907
Power driven metal-working machinery	430,556	554,427	757,163
Other metal-working machinery	83,574	131,479	187,612
Textile machinery	247,612	330,432	395,526

Exports of Metal-Working Machinery During May, 1933

	May, 1933	April, 1933	May, 1932
Engine lathes	$7,679	$3,470	$15,083
Turret lathes	11,255	6,407	2,700
Other lathes	6,763	279	15,484
Vertical boring mills	8,848	2,265	27,740
Thread-cutting and automatic screw machines	19,524	19,547	1,519
Knee and column type milling machines	2,563	200	28,157
Other milling machines	14,685	15,461	22,099
Gear-cutting machines	31,962	25,236	23,115
Radial drilling machines	.....	530	250
Vertical drilling machines	9,639	5,901	3,613
Other drilling machines	7,570	24,451	34,970
Planers and shapers	2,753	26,794	34,075
Surface grinding machines	3,432	650	1,920
External grinding machines	34,463	1,034	34,994
Internal grinding machines	9,225	850	3,532
Tool grinding, cutter grinding and universal grinding machines	18,073	5,152	10,072
Other metal grinding machines	8,894	12,051	22,439
Sheet and plate metal working machines	53,087	65,008	158,862
Forging machinery	12,741	18,839	114,196
Rolling mill machinery	51,514	17,565	4,476
Foundry and molding equipment	18,558	145,658	12,819
Other power-driven metal-working machinery and parts	97,308	157,179	185,228

Other Metal-Working Machinery

Pneumatic portable tools	14,861	27,736	21,033
Other portable hand operated machines and parts	17,514	22,876	97,419
Chucks for machine tools	2,871	4,077	2,553
Machine operated pipe and thread cutters, stocks, dies, taps and other machine-operated cutting tools	26,039	49,195	47,763
Other metal-working machine tools	22,289	27,593	18,844

Farm Machinery Exports Rise 10 Per Cent

Agricultural implement exports for May were 43 per cent higher than the same months of last year and 10 per cent above the April figure. A value of $1,016,235 compared to $918,000 in April and $708,916 for May, 1932, according to a Commerce Department report.

Foreign shipments of wheel tractors of the 15 to 32 belt hp. type, tracklaying tractors, parts and accessories and harvesting implements accounted for most of the gain. Comparatively large increases were also made in sales of combines and seed separating machinery.

Leipzig Fair in August

Despite the effects of the depression, it is anticipated that the Leipzig Fall Fair to be held August 27-31 will be three times the size of any prewar fair. Exhibits will include the newest products in every industrial field. It is hoped that efforts now being made to reduce international trade restrictions will add to the timeliness of this event.

• BUSINESS ITEMS •

The Allsteel Press Co., 12015 S. Peoria St., Chicago, Ill., manufacturer of the "Verson" Allsteel line of punch presses and sheet metal-working machinery, has appointed the W. G. Nichol Co., Mariner Tower, Milwaukee, as representative in the state of Wisconsin.

The National Electric Welding Machines Co., 1846-1860 N. Trumbull St., Bay City, Mich., has been organized to manufacture a complete line of standard and special resistance welding machines.

The Bryant Machinery & Engineering Co., 400 West Madison St., Chicago, Ill., has appointed JAMES R. MURPHY as representative in the Milwaukee territory with headquarters at 610 W. Michigan St., Milwaukee. He will handle the sales of all the lines for which Bryant is general distributor.

The Yale & Towne Mfg. Co., Philadelphia division, has appointed GEORGE C. ISBESTER to direct the sale of the Yale hand and electric trucks and tractors to the railroads in the midwestern territory. His offices are at 713 Railway Exchange Bldg., Chicago, Ill.

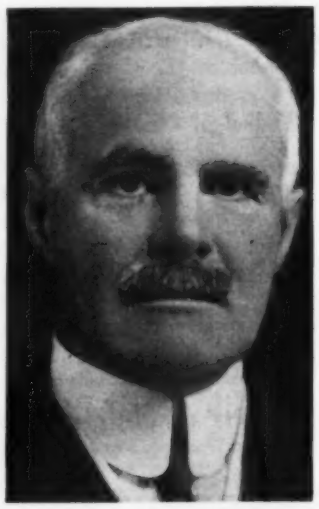
The Ex-Cell-O Aircraft & Tool Corp. has appointed L. W. SHEEHY as representative in the New England territory with headquarters at 51 Washington Ave., Cranston, R. I. Mr. Sheehy will handle the products of the Continental and Krueger-Wayne divisions in addition to those of Ex-Cell-O.

The Modern Collet & Machine Co., Ecorse, Mich., has appointed the Production Tool & Supply Co., 2832 Easton Ave., St. Louis, as representative in Missouri.

• OBITUARIES •

F. N. MacLeod Dies

Frank Norman MacLeod, founder and president of the Abrasive Machine Tool Co., Providence, R. I., died June 25 after an illness of two years. He was 67. Mr. MacLeod was formerly vice-president and director of the National Machine Tool Builders' Association. He started to work in 1886 at the Corliss Steam Engine Works, Providence, and after three years went with Brown & Sharpe as assistant inspector of machine tools. He later was promoted to chief inspector, which job he held for five years. In 1897 he went to Europe as general representative for Brown & Sharpe and was



one of the pioneers in introducing American machinery in Europe. About 1913, he took charge of the grinding machine end of the business. In 1916, he organized the Abrasive Machine Tool Co.

EMORY O. PENRY, vice-president of the Auburn Automobile Co., and a director of the Cord Corp., died July 2 at the age of 49. Mr. Penry started with Auburn as a tester 22 years ago, became superintendent and then was made general manager of production.

GORDON GORDON, president, treasurer and a director of the Taft-Peirce Mfg. Co., Woonsocket, R. I., died June 28. He was also secretary and treasurer of the J. D. Crosby Co., Pawtucket.

DAVID J. POST, founder of the Veeder Mfg. Co., with Curtis H. Veeder, inventor, and a director of Veeder-Root, Inc., president of Post & Lester, Inc., chairman of the board of the Hall-Thompson Co. and the Billings & Spencer Co., and a director of the Holo-Krome Screw Corp., died June 25.

L. G. ALDRICH, in charge of the Chicago office for the Landis Tool Co., Waynesboro, Pa., died June 10 at the age of 40.

CHARLES MALISCHKE, 60, president of the Charles Malischke Co., Milwaukee, manufacturer of tools, dies and jigs, died June 21.

KARL PETERSON, 67, president and founder of the Crescent Tool Co., Jamestown, N. Y., died June 20.

WILLIAM L. SAUNDERS, vice-president of D. Saunders Sons, Inc., manufacturers of tools was fatally injured in an automobile accident on June 22.

WILLIAM F. SELLERS, who recently retired as president of the Edge Moor Iron Co., and who was a director of William Sellers & Co., Philadelphia, died June 14, at the age of 77.

• PERSONALS •

WILLARD F. ROCKWELL, president of the Wisconsin Axle Co., has been elected president of the Timken-Detroit Axle Co., of which the former company is a subsidiary.

R. B. WILSON has been made manager of the St. Louis plant of Joseph T. Ryerson & Son, Inc., formerly having been sales manager. Mr. Wilson has been with the Ryerson company for 20 years.

H. G. HOGLUND has been appointed sales manager of the Machine Tool Division, Van Norman Machine Tool Co., Springfield, Mass., Mr. Hoglund was formerly a representative of the General Electric Co., in New England.

• MEETINGS •

SILVER BAY INDUSTRIAL CONFERENCE. Sixteenth annual conference on industrial relations. August 23–26. Silver Bay on Lake George, N. Y. E. C. WORMAN, secretary, 347 Madison Ave., New York, N. Y.

SOCIETY OF AUTOMOTIVE ENGINEERS. International automotive engineering congress. August 28–September 4. Palmer House, Chicago. JOHN A. C. WARNER, general manager and secretary, 29 West 39th St. New York, N. Y.

THE ROUND TABLE

Thirty-Hour Week

"Hello, Ed. What have you been doing? I haven't seen you lately."

"I've been getting in some fishing, Al. They're biting good now."

"Well, you ought to have plenty of time for it this summer with the 30-hour week coming along."

"You're thinking about the Black Bill and that was killed long ago. I thought you read the papers. We've been working 45 hours since April."

"I do read the papers. The Black Bill's dead all right but not the 30-hour week. That's been sugar-coated so industrial leaders could take it, and now it's part of the Recovery Act. It may not exactly say 30 hours, but it means practically the same thing."

"I can stand it all right if they give me the same pay, and I understand that's part of the idea. But how will it affect your business?"

"That's what worries me, Ed. I'm glad I had the foresight to get into my new plant in spite of your gloomy predictions. But even so, I'm up to my neck in work now. I simply won't be able to meet my deliveries on a 30-hour basis."

"You'll have to take on more men, Al. After all the main object of the law is to increase employment."

"I took on three more men last week, and now I have all I can use with my present equipment. I'm not ready to buy any more new machines yet."

"Then your best bet is to start a second shift. That'll help you get out your orders, employ more men, and give you greater use out of your present equipment."

"That's well and good for large shops set up for it. But our position is different. Remember, Ed, the compressors are still on an engineering basis and need close supervision. I don't intend to work two shifts myself, and I can't let any Tom, Dick or Harry run the night force. It would take me all day to correct the things that went wrong at night. Besides, I think the 30-hour idea is wrong from the start. My men have no real desire for such short hours and wouldn't be any happier if they had them. We've got to educate ourselves to make better use of our leisure before we come to anything like that."

"Al, it's not a question of coming to it—it's practically here. Lots of manufacturers large and small will find reasons why they can't conform. But when they're told to find a way, they'll find it. As for leisure—30 hours will look like overtime to the men who've been working two days a week or not at all."

"Ed, one trouble with this country is that we try to rush things too much. A shorter week has been coming for years by a process of evolution. Just because the trend is in the right direction, we try to legislate it over night. I'd much rather see a more moderate normal recovery."

"We've been waiting for that for three years. Most people have made up their minds that business activity isn't spontaneous. And a slow improvement isn't much satisfaction to a man out of work."

Will the short working week aid industrial recovery? Are Al's objections sound?

Discussion

One Channel

Considered from all angles with the possible exception of bookkeeping, Al is making a serious mistake by trying to hold to one source of supply. The main objections are as follows:

Credit: While a small concern is operating under normal conditions, one supply house could carry its account without any question; however, in times of expansion, when purchases become abnormal, the account is likely to be questioned and limited to the extent of handicaping a small concern. On the other hand, a heavy program could be distributed among several supply houses without any trouble.

Prices: Under a one source system, prices are bound to be higher or quality lessened, as no one supply house has a stock of all leading articles, and when they are required to go out and make purchases, extra shipping and billing is required which must be paid by some one. Dealers dislike purchasing competitive articles to those that they already have in stock.

Salesman's Opinion: Salesmen quickly form opinions regarding the manufacturers on whom they call and these opinions expressed when in the negative do not help the manufacturer who has cut them off entirely by purchasing from one source of supply. — C. F. Staples.

Keeping Time

Timekeeping and cost accounting in a small shop, like planning, scheduling, and other functions, may be made absurd if carried out to the same extent as in a large shop. But there is a danger of underestimating the value of accurate costs. If you are building only com-

pressors of a single type, it is simple enough to divide the total cost for a certain period by the number of compressors produced to get the cost per unit. But when you begin to make replacement parts and when you branch out into different sizes or types, it becomes necessary for you to have more accurate knowledge of costs. Even then, without competition, it is possible to insure a profit by adding an amount to the selling price to compensate for any errors in estimating cost. But it leaves an opening for a competitor to take the cream of the business, leaving you with only those items on which you underestimated cost.

Before the war there was a tendency to keep records in minute detail. This brought a reaction in many places with whole systems abandoned. There seems to be a feeling now that a cost system should be simple but effective.

—HARRISON G. BROWN,
Supervisor of Standards,
Crompton & Knowles Loom Works.

A Better Shop

If Al wants to do something for his men besides giving them pay checks, there are numerous inexpensive things he can do that will help. One thing is to compliment a man on a good job. A few words will make a man feel better and want to do better because in most places he only hears about the poor jobs. Another thing that will benefit both sides is not to take all the personal liberties from his men. A man who likes to smoke will do better if allowed to smoke on the job.

Al can make his shop desirable to workers if he wants to spend some money by doing a number of things such as furnishing soap and towels, free laundry service for work clothes, having late technical magazines and books for his men to take home for a few days, organizing some kind of cooperative purchasing system for food and family necessities and possibly some provision for ordinary doctor and health expenses.

There are also some things he should not do, such as trying to get "chummy" with the men, and he should not try to help his men by depriving them of their leisure time or by bragging about what good things he is doing for them.

—F. F. ANDERSON.

There are many privileges and favors an employer can give to the employees and at the same time omit any tendency toward making a kindergarten out of a manufacturing plant. It is a known fact that certain recreational privileges given to employees during working hours tend to break down discipline rather than maintain it.

A safe and sane way to promote happiness and enthusiasm among workers is to improve actual working conditions. One way of doing this is through the purchase of better equipment; old troublesome machinery and tools is the cause of much dissatisfaction in the shop. Another thing which is appreciated by the workmen is a change of jobs thus breaking up the daily monotonous routine.

If space is available, the creation of a recreation room containing a few game tables, and a small library of books and periodicals will prove satisfying to the early comers and those who carry their lunch. If possible, a short vacation with pay given to earnest workmen during the summer will provide an excellent incentive because an opportunity of this kind causes the men to return to their job with doubled energy.

—PETER L. BUDWITZ.

Follow the Leader

If Al and Mason are in the fortunate position of being able to consider paying higher than standard wages after taking care of all other legitimate manufacturing costs, including a reasonable amount of research, they should, instead, consider something much more desirable and far reaching—namely a cut in prices.

Primarily this would mean increased volume for them with presumably a better utilization of their facilities, more efficient production and greater total profits. It would also mean more work for the men of their community at reasonable wages. Surely it would be

better to have a large number of men employed with steady work at moderate wages than to have a few on part time at high wages with the rest living "on relief."

The effect of reduced prices on other industries might be even more beneficient and far reaching. A lower price for compressors, or on other machinery of moderate or wide adaptability, is likely to open up whole new fields of usefulness otherwise closed for economic reasons, resulting in the development of new industries, the employment of thousands of men, and a higher standard of living for millions of people to whom the new product or service would become available. —N. G. MORGAN,
Morgan Brothers.

Is Talk Cheap?

I interview salesmen and always remember that they may have families, as I have, and are depending on their salaries to support them. I always let them have the floor and listen to what they have to say. I then give my opinion as to whether or not the tools they have to sell will stand a chance of being purchased, leaving the decision up to the superintendent, to whom I make my report. If the salesman is a good one, he will take his leave as soon as the decision has been made.

However, there are some salesmen who will talk you to death about what they have to sell, about trips they have made, and about their experiences in selling. When I get tied up with such a salesman, I let him do all the talking, thinking he will soon get tired and quit. If he does not, I give one of my men the high sign and he goes out in the shop and phones me that one of the foremen want to see me. I hang up the phone and tell the salesman I am sorry, but that I am wanted out in the shop. Al could work the same racket and save himself much time. —C. D. HAEDRICH,
Chief Draftsman, Artillery Department,
Frankford Arsenal.

Production Control

The growing small manufacturer should slowly but surely prepare a firm foundation for a simple cost accounting system before entertaining production control. To obtain costs efficiently, fundamentals must be strictly adhered to. Aside from the necessary clerical effort, it is paramount that the engineering department produce designs that are consistent with available machine equipment. It is also accepted practice to have each component required for the finished major assembly detailed and assigned a separate drawing number.

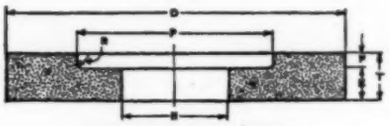
As part of the production activities, a perpetual inventory or stock record must be inaugurated, which should illustrate at all times the number of finished or raw parts in process or in the stockroom. This general outline may be in the process of formulation over a considerable period but not until it has proved itself capable of further projection should production control be instituted.

Wonders can be accomplished by intensive personal supervision together with a unified study of fixture requirements. Production control is the last word in scientific management, and until an enterprise has expanded to where personal contact has lost its usefulness, then and only then, should a system of production control be installed.

—HAROLD L. WYNN, *Executive Engineer,*
Pacific Electric Mfg. Corporation.

American Machinist
REFERENCE BOOK SHEET

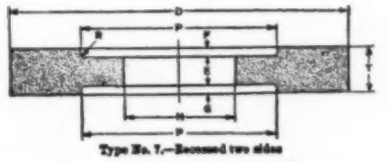
Standard Types of Grinding Wheels—II



Type No. 5.—Recessed one side

TABLE 12.—*Type No. 5, wheels (recessed one side)*

D Diameter, in inches	T Thickness	H Arbor hole	Recess P Diameter	Recess F Depth	D Diameter, in inches	T Thickness	H Arbor hole	Recess P Diameter	Recess F Depth
	Inches	*Inches*	*Inches*	*Inch*		*Inches*	*Inches*	*Inches*	*Inches*
¾	¼	⅜	½	⅛	3½	⅝	⅝	1¾	⅛
¾	⅜	⅜	½	⅛	3½	⅝	1¼	2¼	⅛
¾	½	⅜	½	⅛	3½	1	⅝	1¾	⅛
¾	⅝	⅜	½	⅛	3½	1	1¼	2¼	⅛
¾	¾	⅜	½	⅛	3½	1¼	⅝	1¾	⅛
⅞	⅜	½	⅝	⅛	3½	1¼	1¼	2¼	⅛
⅞	½	½	⅝	⅛	4	⅝	⅝	1¾	⅛
⅞	⅝	½	⅝	⅛	4	⅝	1¼	2¼	⅛
1	⅜	½	⅝	⅛	4	¾	⅝	1¾	⅛
1	½	½	⅝	⅛	4	1	1¼	2¼	⅛
1	¾	½	⅝	⅛	4	1¼	1¼	2¼	⅛
1	⅝	½	⅝	⅛	4½	⅝	⅝	1¾	⅛
1	¾	½	⅝	⅛	4½	¾	1¼	2¼	⅛
1¼	⅜	½	⅝	⅛	4½	1	1¼	2¼	⅛
1¼	½	½	⅝	⅛	5	⅝	1¼	2¼	⅛
1¼	¾	½	⅝	⅛	5	1	1¼	3¼	⅛
1½	⅜	½	⅝	⅛	6	¾	1¼	2¼	⅛
1½	½	½	⅝	⅛	6	1	1¼	2¼	⅛
1½	¾	½	⅝	⅛	7	¾	1¼	2¼	⅛
1½	1	½	⅝	⅛	7	1	1¼	2¼	⅛
1¾	¾	½	⅝	⅛	14	1½	⅝	9	½
2	⅜	½	⅝	⅛	14	2¼	⅝	9	½
2	½	½	⅝	⅛	14	2½	⅝	9	½
2	¾	½	⅝	⅛	14	3	⅝	8	1
2	1	½	⅝	⅛	14	3	⅝	9	1
2¼	¾	½	⅝	⅛	14	3¼	⅝	8	1¼
2¼	¾	⅝	1⅛	⅛	14	4	⅝	8	2
2½	¾	1¼	2⅛	⅛	14	4	⅝	9	2
2½	1	⅝	1⅛	⅛	18	2½	⅝	8½	½
2½	1¼	⅝	1⅛	⅛	18	3	⅝	8½	1
2¾	¾	1¼	2⅛	⅛	18	3½	⅝	8½	1½
2¾	1	⅝	1⅛	⅛	18	4	⅝	8½	2
2¾	1¼	⅝	1⅛	⅛	20	2½	⅝	8½	½
3	¾	⅝	1⅛	⅛	20	3	⅝	8½	1
3	¾	1¼	2⅛	⅛	20	3½	⅝	8½	1½
3	1	⅝	1⅛	⅛	20	4	⅝	8½	2
3	1	¾	1⅛	⅛	24	2½	⅝	10½	½
3	1	1¼	2⅛	⅛	24	3	⅝	10½	1
3	1	1¼	2⅛	⅛	24	3½	⅝	10½	1½
3	1½	⅝	2⅛	⅛	24	4	⅝	10½	2
3	1½	1¼	2¼	⅛					



Type No. 7.—Recessed two sides

TABLE 14.—*Type No. 7, wheels (recessed two sides)*

D Diameter, in inches	T Thickness	H Arbor hole	Recess P Diameter	Recess F Depth	Recess G Depth
	Inches	*Inches*	*Inches*	*Inch*	*Inches*
12	1½	⅝	7½	3/16	3/16
12	1½	⅝	7½	¼	¼
14	1½	⅝	7½	5/16	5/16
14	2	⅝	7½	3/16	1/16
14	2	⅝	7½	5/16	1/16
14	4	⅝	8	⅜	⅜
14	5	⅝	8	½	½
16	6	⅝	8	½	½
18	3	⅝	11	⅜	⅜
18	3¼	⅝	11	⅜	⅜
18	3	⅝	11	⅜	⅜
20	1¼	12	13¼	5/16	5/16
20	1½	12	13¼	5/16	5/16
24	1½	12	13¼	⅜	⅜
24	1¾	12	13¼	5/16	5/16
24	2	12	13¼	5/16	5/16
24	3	12	14¼	3/16	3/16
24	3¼	12	13¼	⅜	⅜
24	2¼	12	14¼	3/16	3/16
24	2½	12	13¼	5/16	5/16
24	2¾	12	14¼	5/16	5/16
24	3	12	14¼	3/16	3/16
24	3¼	12	13¼	⅜	⅜
24	3¼	12	14¼	3/16	3/16
24	3	12	13¼	1/16	1/16
24	3	12	14¼	1/16	1/16
24	3¼	12	14¼	1/16	1/16
24	3½	12	14¼	1/16	1/16
24	4	12	14¼	1/16	1/16
30	2¼	12	13¼	⅜	⅜
30	2½	12	14¼	5/16	5/16
30	2¾	12	13¼	⅜	⅜
30	3¼	12	14¼	5/16	5/16
30	2¾	12	13¼	⅜	⅜
30	2¾	12	14¼	5/16	5/16
30	3	12	13¼	⅜	⅜
30	3	12	14¼	1/16	1/16

TABLE 13.—*Type No. 5, cylindrical grinding wheels (recessed one side) recommended for new machine design*

D Diameter, in inches	T Thickness, in inches	H Arbor hole	P Diameter of recess
		Inches	*Inches*
14	As ordered	5	8
18	do	5	8½
20	do	5	8½
24	do	5	10½

Depth of recess for type No. 5 wheels—
With T 2 inches and less ... F=0.
With T 2½ inches ... F=½ inch.
With T 3 inches ... F=1 inch.
With T 3½ inches ... F=1½ inches.
With T 4 inches ... F=2 inches.

TABLE 15.—*Type No. 7, cylindrical grinding wheels (recessed two sides), recommended for new machine design*

D Diameter, in inches	T Thickness, in inches	H Arbor hole	P Diameter of recess	D Diameter, in inches	T Thickness, in inches	H Arbor hole	P Diameter of recess
		Inches	*Inches*			*Inches*	*Inches*
14	As ordered	5	8	24	As ordered	5	11
18	do	5	8	24	do	12	14¼
18	do	8	11	24	do	12	14¼
20	do	8	11	30	do	12	14¼
20	do	12	14¼	30	do	30	23¼

DEPTH OF RECESS FOR 8, 12, AND 20 INCH HOLES

T Thickness, in inches	Depth of recess F	Depth of recess G
	Inch	*Inch*
With T less than 2 inches	0	0
With T from 2 inches up to 3 1/16, inclusive	5/16	3/16
With T 3 inches and larger	1/16	1/16

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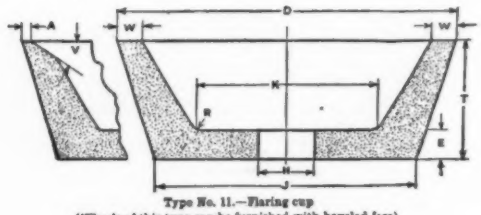
REFERENCE BOOK SHEET

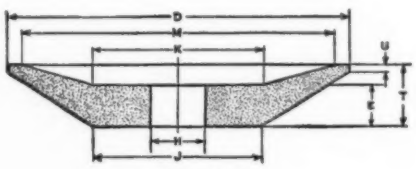
Standard Types of Grinding Wheels—II



Type No. 11.—Flaring cup
(Wheels of this type can be furnished with beveled face)

TABLE 16.—*Type No. 11 flaring-cup wheels*

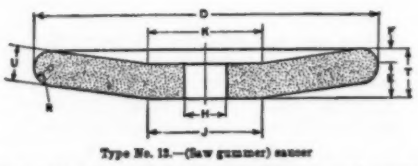
Straight face								Bevel face	
D Diameter, in inches	T Thickness	H Arbor hole, in inches	W Thickness of wall	E Center or back thickness	J Diameter of flat or small diameter	K Diameter of flat inside	R Radius	A Flat spot of beveled wall	V Angle of bevel
	Inches		*Inch*	*Inch*	*Inches*	*Inches*	*Inch*	*Inch*	°
3	1¼	As ordered	⅛	⅜	2¼	1⅝	1/16	⅛	30
3½	1½	do	⅛	⅜	2½	1⅞	1/16	⅛	30
3½	1½	do	⅛	⅜	2⅝	2⅛	1/16	⅛	30
4	1½	do	⅛	½	3	2⅜	1/16	⅛	30
4½	2	do	⅛	½	3¼	2⅝	1/16	⅛	30
5	1¾	do	⅛	½	3¾	3⅛	1/16	⅛	30
6	2	do	⅛	½	4½	3¾	1/16	⅛	30
7	2	do	¼	½	5	3¾	1/16		



Type No. 12.—Dish

TABLE 17.—*Type No. 12 dish wheels*

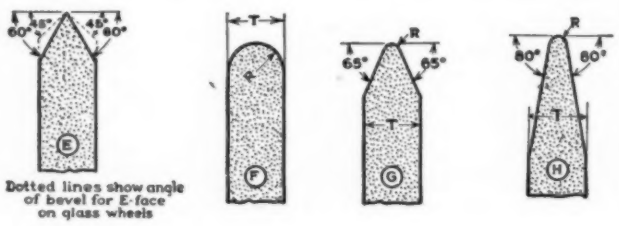
D Diameter, in inches	T Thickness	H Arbor hole, in inches	E Center or back thickness	K and J Diameter of flat inside and diameter of flat or small diameter	U Width of face	M Large diameter of bevel
	Inch		*Inch*	*Inches*	*Inch*	*Inches*
3	½	As ordered	1/16	1⅛	1/16	2¾
3½	½	do	1/16	1¾	1/16	3⅛
4	½	do	1/16	2	1/16	3⅝
4½	½	do	1/16	2¼	⅛	4
5	½	do	1/16	2½	⅛	4½
6	½	do	1/16	3	⅛	5¼
6	¾	do	⅛	3	⅛	5¼
8	¾	do	⅛	4	⅛	7
8	1	do	⅛	4	⅛	7

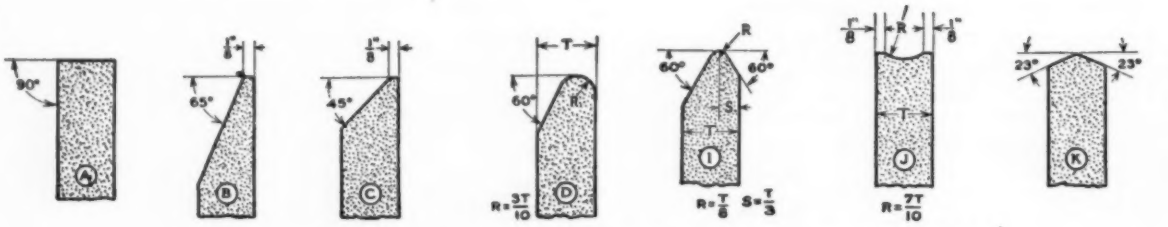


Type No. 13.—(Saw gummer) saucer

TABLE 18.—*Type No. 13, wheels (saw gummer) saucer*

D Diameter, in inches	T Thickness	H Arbor hole, in inches	E and U Center or back thickness and width of face	K Diameter of flat inside
	Inches		*Inches*	*Inches*
6	½	As ordered	¼	3
6	⅝	do	5/16	3
6	¾	do	⅜	3
6	⅞	do	7/16	3
6	1	do	½	3
6	1⅛	do	9/16	3
6	1¼	do	⅝	3
6	1⅜	do	11/16	3
6	1½	do	¾	3
8	½	do	¼	3
8	⅝	do	5/16	3
8	¾	do	⅜	3
8	⅞	do	7/16	3
8	1	do	½	3
8	1⅛	do	9/16	3
8	1¼	do	⅝	3
8	1⅜	do	11/16	3
8	1½	do	¾	3
10	½	do	¼	3½
10	⅝	do	5/16	3½
10	¾	do	⅜	3½
10	⅞	do	7/16	3½
10	1	do	½	3½
10	1⅛	do	9/16	3½
10	1¼	do	⅝	3½
10	1⅜	do	11/16	3½
10	1½	do	¾	3½
12	½	do	¼	4
12	⅝	do	5/16	4
12	¾	do	⅜	4
12	⅞	do	7/16	4
12	1	do	½	4
12	1⅛	do	9/16	4
12	1¼	do	⅝	4
12	1⅜	do	11/16	4
12	1½	do	¾	4





The shapes of grinding wheels shown above are recommended, but grinding machines designed to accommodate the eliminated sizes will still be serviced.

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Hidden Costs in Machine Tool Building

THE MACHINE TOOL industry, although absolutely essential to all other industries, is small in the total volume of product as compared with the industries which depend on it for existence. It is composed, for the most part, of a number of small shops. Although the Census of 1929, a peak year, gave 280 shops with 47,391 employees, approximately 75 per cent of the total product came out of 20 shops, the other 260 concerns building only 25 per cent of the total output. Assuming that the number of employees varied with the output, the 260 small shops averaged only 45 men each. While this assumption is not quite correct, as the large shop should be more efficient, it gives a fair idea of the size of the average machine tool shop.

The progressive machine tool shop requires a much larger staff of skilled designers and engineers, in proportion to the volume of the product, than almost any other industry. The design of modern machine tools requires men of long experience in this special line, men whose training has developed a kind of sixth sense regarding the functioning of the mechanical elements that enter into the machines they build. For example, men experienced in automatic screw machinery can design machines to handle any sort of turned work automatically. They would, however, have much more difficulty in designing automatic wire forming or other special machinery.

The machine tool industry also requires a much higher grade of skill in its workmen than many of the industries using its machines. Machine tool shops build machines that enable mass production shops to secure large outputs at astonishingly low costs. The small volume of machine tool output, however, usually prevents the use of the large production machines and methods in their own shops. This means that the building of machine tools requires not only more highly skilled men, but more of them in proportion to the volume of the output.

The thirty-one builders of machine tools who favored us with figures showing their costs for design, engineering and development, as compared with their total cost of production, are all well known. These percentages of development costs vary widely, as will be seen in the accompanying table. Among the reasons for the variations are the kind of product, the quantity of machines built and the methods of accounting.

The thirty-one replies have been condensed into twelve lines in order to disguise still further the identity of the concerns who were good enough to give us their confidential data for this purpose.

Some of the differences in development costs for similar machines are due to the organization of the plant concerned. Extremely low cost is likely to indicate that comparatively few changes have been considered necessary in these cases. The very high costs, on the other hand, may point either to very radical redesigning, or to engineering departments that were not as well equipped with the experience that lies behind all successful machine tool development.

The high percentages shown are influenced to a considerable extent by the limited output over which the costs can be spread. For the large production secured from many machine tools automatically limits the number that can be used. The special crankshaft lathe is a good example of high engineering cost and a limited market. There are also instances where the costs of design and development exceed the probable gross sale of the machine when completed.

Design, however brilliant, is only part of the story in the development of efficient machine tools. There have been many cases where blue prints and patterns have been sold or otherwise transferred to a shop unacquainted with the particular machine, with disappointing results. Even machine tool shops accustomed to building one class of machine frequently require time and expensive experience to turn out a really satisfactory product in another line. Shops with no machine tool experience must of necessity expect even more difficulty in learning the ins and outs of the business.

It is not the intention to give any impression of mystery or magic in the building of machine tools. Far from it. It is not necromancy but experience that is needed—experience as to the particular kind of fits needed in different parts of the machine, experience as to what metals and what kind of bearings give best results in different places.

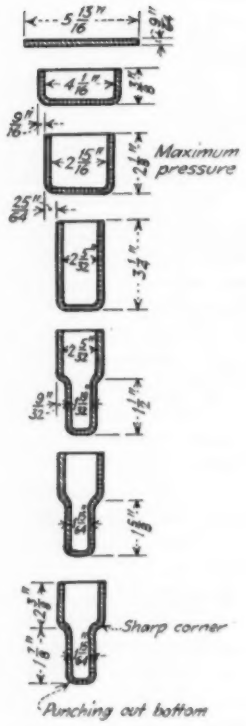
Anyone who tries to build acceptable machine tools without the necessary experience will find it a costly experiment. But the trial will vastly increase his respect and appreciation for the builders who have paid the price for learning how successful machine tools must be built.

Costs of Design, Engineering and Development from 31 Machine Tool Builders, in Percentage of Total Production Cost

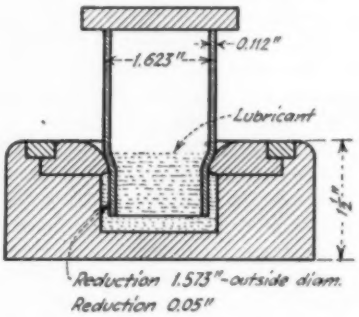
—Lathes—		—Drills—		—Milling—		—Grinding—			—Boring—		
General	Special	General	Special	General	Special	General	Special	Gear Cutting	General	Special	Planer-Shaper
5	..	9	..	..	13	5	10	12	..	10	12
..	15	..	10	12	18	..	8	..	15	..	..
..	17	..	..	..	10	..	36	..	7	..	..
..	9	..	..	..	..	..	..	..	..	10	..
..	13	..	15	..	..	4	..	25	7	12	..
7	20	..	..	5	..	15	25	..	..	13	14
..	16	..	..	..	..	..	..	..	10	15	..
..	20	..	..	..	..	..	..	..	6	..	..
7	38	7	11	5	12	..	15	..	5	..	..
6	..	..	..	..	..	..	..	..	..	6	..
..	15	..	..	18	25	20	22	20	..	..	10

Press Work Pressures

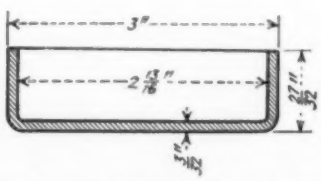
Series X—*Drawing*



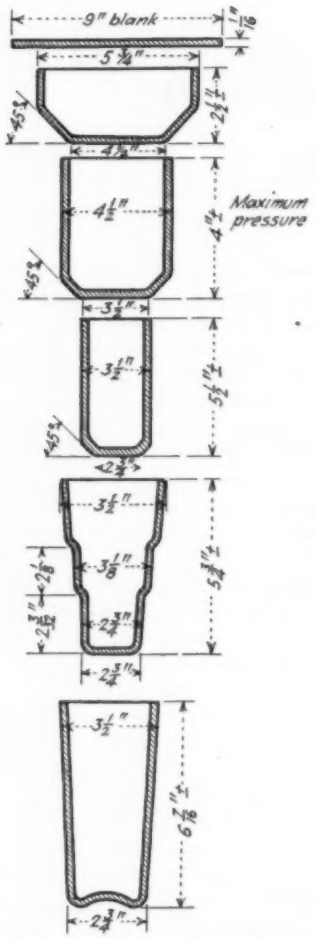
Material--Low-carbon drawing steel, 9/64 in. thick by 5 13/16 in. in diameter
Operation--Form cups as shown
Pressure--200,000 lb. maxium
Too heavy for 70-ton press



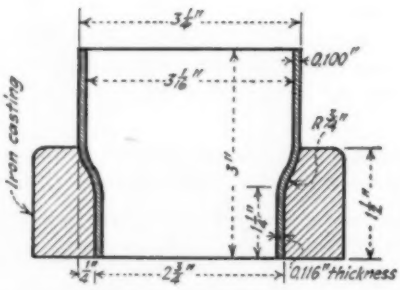
Material--Steel, 0.112 in thick
Operation--Reduce outside diameter by 0.05 in.
Pressure--5,000 lb.



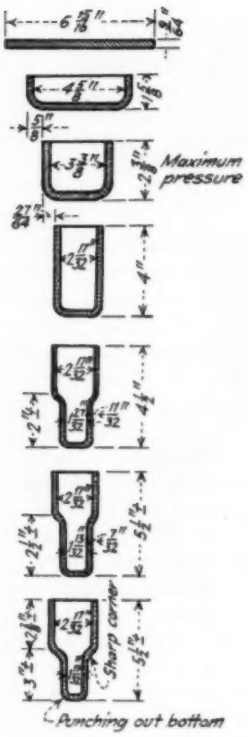
Material--Soft decarbonized steel, 3/32 in. thick
Operation--Draw drum as shown
Pressure--35 tons



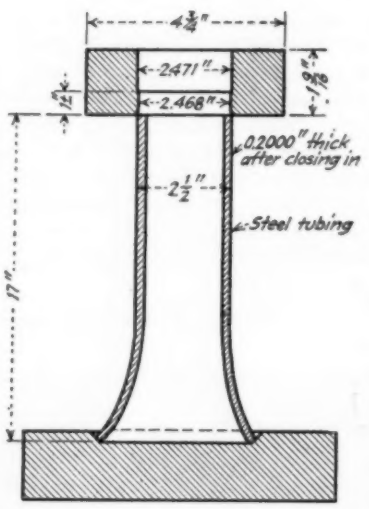
Material--brass, German silver, aluminum or steel - 1/16 in. thick
Operation--Draw tapering cup and finish smooth on the outside
Pressure--140,0001b.



Material--Soft steel, 0.100 in thick
Operation--Reduce 1/2 in. on the diameter
Pressure--23,500 lb.



Material--Low-carbon drawing steel, 9/64 in. thick by 6 15/16 in. in diameter
Operation--Form cups as shown
Pressure--200,000 lb. maximum

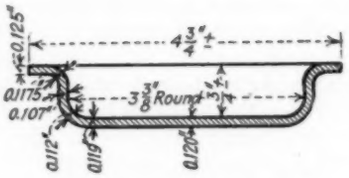


Material--Steel tubing
Operation--Force ring over tubing to reduce it 0.029 in. in diameter
Pressure - 10 tons

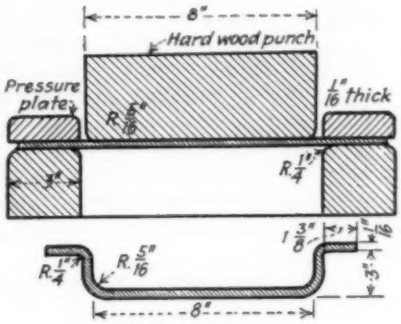
Contributed by C. W. LUCAS © *American Machinist*

Press Work Pressures

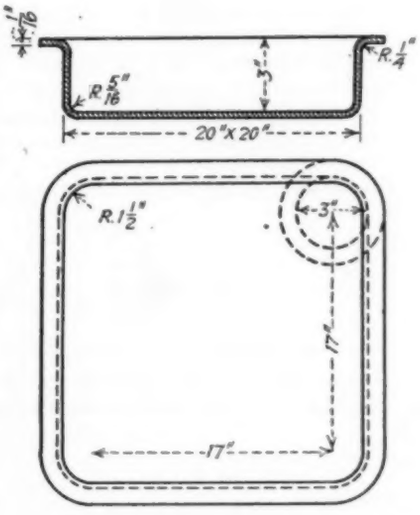
Series X—*Drawing*



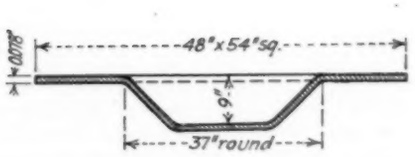
Material--Soft drawing steel
Press--70-ton capacity



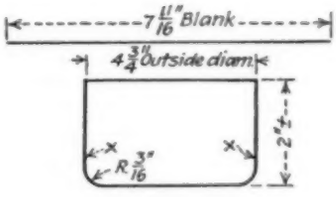
Material--Soft drawing steel, 1/16 in. thick by 5 in. wide
Operation--Only slight pressure placed on the blank by pressure plates. After drawing both sides were curved about 0.010 inward
Pressure--5,000 lb.



Material--Soft drawing steel, 1/16 in. thick
Operation--Draw shell
Pressure--51-1/2 tons

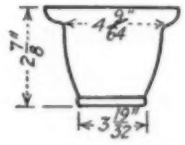


Material--Drawing steel, 0.078 in. thick. Blank, 48x54 in.
Operation--Draw cup in a single-action 400-ton press. Pneumatic die cushion used, 75 tons capacity
Pressure--To tear shell on 37 in. circle required 274 tons



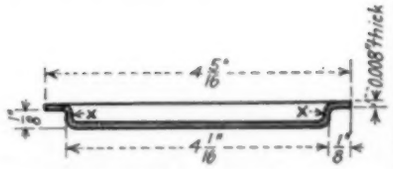
First Operation

Material--Soft steel, 0.014 in. thick by 7-11/16 in. in diameter
Operation--1st drawing operation
Pressure--7,000 lb. to draw 1/4 of total depth, or 1/2 in. deep
7,400 lb. to draw 1/2 of total depth, or 1 in. deep
6,000 lb. to draw 3/4 of total depth, or 1-1/2 in. deep
4,400 lb. to draw the full depth or 2 in. deep
7,500 lb. to draw
12,534 lb. required to tear apart at x - x

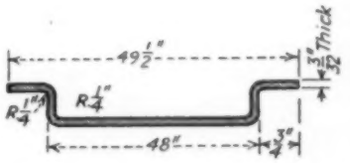


2nd Operation

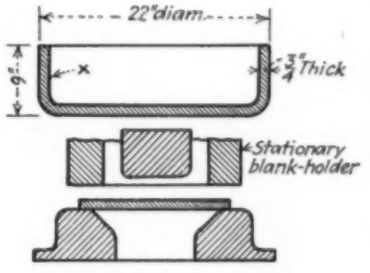
Operation--2nd operation
Pressure--4,200 lb. required to draw 1/4 of depth, or 23/32 in. deep
4,600 lb. required to draw 1/2 depth, or 1-7/16 in. deep
5,800 lb. required to draw 3/4 of depth, or 2-5/32 in. deep
9,800 lb. required to draw within 5/32 in. of full depth
26,000 lb. required to draw full depth, or 2-7/8 in. deep



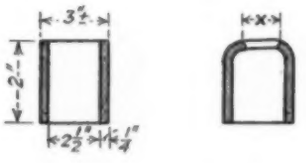
Material--Tin plate, 0.008 in. thick
Operation--Draw as shown
Pressure--500 lb. to hold the flange
2,500 lb. to draw to depth
3-1/6 tons to tear apart at x - x



Material--Soft drawing steel, 3/32 in. thick
Operation--Draw as shown
Pressure--If drawn on a single-action press, a 300-ton press is recommended



Material--Soft steel, 3/4 in. thick
Operation--Draw brake drum, hot
Pressure--937 tons



Material--Soft machine steel, 2 in. long by 3 in. in diameter
Operation--Reduce at x
Pressure--1/8 in. reduction - 18,000 lb.
1/4 in. reduction - 23,000 lb.
3/8 in. reduction - 32,000 lb.
1/2 in. reduction - 40,000 lb.
5/8 in. reduction - 64,000 lb.

Contributed by C. W. LUCAS *© American Machinist*

IDEAS FROM PRACTICAL MEN

Compound Press Tools

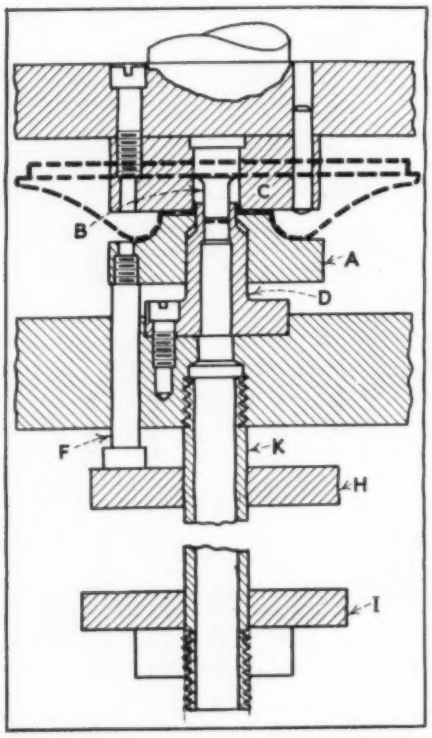
JOHN J. MC HENRY

The tools illustrated were made for piercing holes and drawing vertical flanges about them in can covers made of 0.032-in. cold-rolled steel, a cover being shown in place in the tools. The work was formerly done in two operations, but a change requiring center holes of different diameter gave me the opportunity to try out the one-operation tools shown.

The pressure pad *A* is also used as a nest for locating the work. *B* is the piercing punch and it extends ⅛ in. below the draw ring *C*. Plug *D* acts both as the draw punch and the piercing die. Three shoulder screws *F* act as pressure pins and also retain the pressure pad, being long enough to raise the pressure pad slightly above plug *D*. This is necessary so that the piercing punch will contact with the work and force it to the nest before piercing the holes. The spring, or rubber, for actuating the pressure pad is held between the plates *H* and *I*, and the pipe *K* acts both as a slug tube and a stem for the spring, or rubber.

In operation, a cover is placed on the nest. As the ram descends, the piercing punch contacts with the work and seats it snugly on the nest and then pierces the hole. Next, the draw ring contacts with the work, and continued downward movement against the pressure pad forces the pad down and draws the vertical flange around the plug. As the ram ascends, the spring, or rubber, returns the pressure pad to its topmost position and strips the work from the plug. The clearance between the plug and the draw ring was made 0.025 in., giving a good-looking and straight-sided flange both inside and out, which would not have been the case if greater clearance had been left for the metal.

In addition to cutting out one operation with these tools, we also eliminated the occasional run of covers having flanges higher on one side than on the other.



Holes are pierced and vertical flanges are drawn in can cover parts by the dies shown

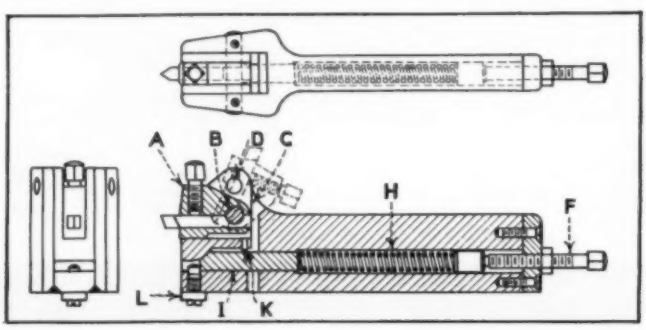
Spring Toolholder for Threading

EMIL WITTMANN

Where a runout for the thread is provided, the adjustable, spring toolholder illustrated makes it unnecessary to back out the tool at the completion of each cut. The tool clamp *A* is pivoted at *B* and can be swung up so that the tool clears the work, as indicated by the dot-dash lines. Both the tool clamp and its pivot are located in the cradle *C*, which is pivoted at *D* between the forks at the front of the toolholder and is therefore prevented from sidewise deflection.

To prevent too much vibration under the pressure of the cut, the amount of spring can be regulated by the screw *F*, which controls the pressure of the spring *H*. This spring acts against the plunger *I*, the beveled end of which contacts with the curved bottom of the cradle to counteract the downward movement of the tool under pressure of the cut. Screw *L* serves as a stop for the plunger and also limits the downward movement of the cradle.

Any vertical deflection of the tool imparted by the stress of the cut causes both the clamp and the cradle to swing as a unit about the pivot *D*, permitting the tool to move in a downward arc and prevent chattering and digging in. Pin *K* in the rear end of the cradle prevents the cradle from swinging upward when the tool and the clamp are swung away from the work by the operator.



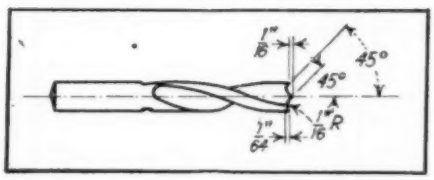
This spring-supported threading tool does not require backing out of the cut if a runout is provided

Drills for Thin Sheet Metals

F. E. FICK

The orthodox method of grinding the lips of twist drills to the standard angle does not work out well for drilling thin sheet metal, as the work climbs up on the drill and makes a rough hole, if it does not do worse—catch and break the drill.

The idea is to grind the drill as illustrated, leaving a point similar in principle to the point on a carpenter's bit, that is, with a pilot in the center and cutting edges at the extreme outer diameter advanced ahead of the intermediate



Drills with points ground in this manner work well on thin sheet metal

cutting edges. Very thin metal can be drilled with a drill so ground with very little tendency to catch or climb on the drill, leaving a nice, smooth, round hole. When a piece of sheet metal is laid out and the center of the hole to be drilled is marked by a center punch, the pilot of the drill is started in the center-punch mark and helps materially in the accurate location of the drilled hole.

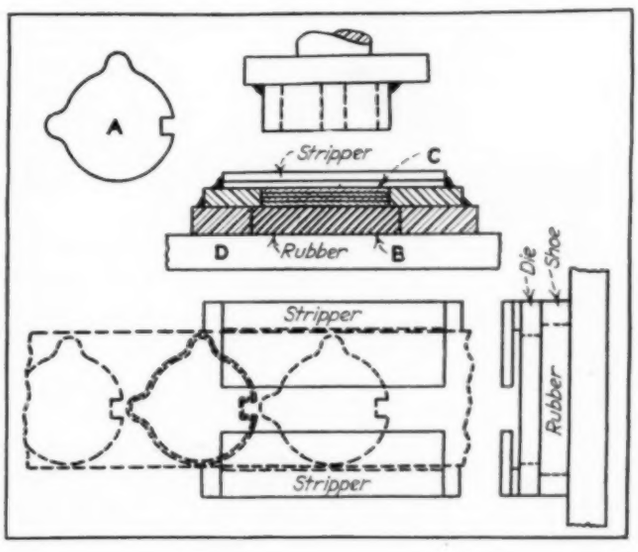
Press Tools for a Short Run

WALTER SIMPSON

The tools illustrated were made for producing but 5,000 pieces, such as the one at *A*. The various parts of the tools are held together by welding, neither screws nor dowels being used in their construction. To eliminate the cost of a trigger stop, the stripper was provided with an opening so that the operator could see how far to advance the stock for each stamping. The rubber block *B* is set in a round hole in the die-shoe, and resting on the rubber and confined in the die is the floater *C* composed of four of the stampings welded together.

In operation, as punching takes place, the blank is forced down on the floater, the movement of which compresses the rubber block. As the ram ascends, the pressure on the rubber is released and it springs back and causes the floater to press the blank back into the stock tightly enough for it to remain there while the stock is advanced. When the blank reaches past the edge of the die it drops out of the stock. The plate *D* is merely to cover the hole in the bolster and acts as a backing for the rubber

Should the die require grinding before the run has been completed, its face can be exposed by removing the stripper by breaking the welds with a chisel. After the die has been ground, the stripper can again be welded in place.



Low cost dies for short runs were made by welding the parts together instead of using screws and dowels. A rubber pad provided the necessary spring

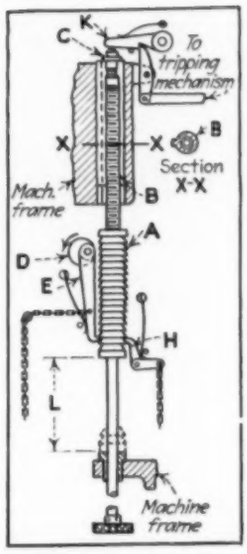
A Variable Stop Mechanism

FORDYCE W. BROWN

While the device illustrated was originally designed for attachment to a polishing machine, it can readily be adapted to installations where the machine is to be stopped after the work spindle has made a predetermined number of revolutions.

Essentially the device consists of the spindle *A* threaded at its upper end and having ratchet grooves turned in the center, and provided with a knurled knob at its lower end; the sliding nut *B* having an integral key and a hardened nose piece *C;* the eccentric shaft *D;* the spring-actuated pawls *E* and *H;* the latch lever *K;* and a tripping mechanism (not shown) for the driving clutch. The sliding nut fits a hole in the machine frame and is prevented from turning by its integral key.

In operation, the eccentric shaft being actuated from any convenient rotating part of the machine, the spindle *A* is lifted a little more than the distance between the ratchet grooves by the pawl *E* at each revolution of the eccentric shaft, permitting the pawl *H* to drop into one of the grooves and prevent the spindle from dropping while pawl *E* is on its downward stroke. This operation results in intermittently raising the spindle until the nose piece on the sliding nut contacts with and lifts the latch lever *K* and unlatches the tripping mechanism of the driving clutch, stopping the machine. The operator then pulls the pawls *E* and *H* out of engagement with the ratchet grooves in the spindle by the chains shown, and the spindle drops until its shoulder strikes a bushing in the machine frame. At the same time the latch lever *K* returns to its normal position. The machine can now be started by re-engaging the driving clutch.



A circular ratchet-toothed bar with suitable pawls and trip mechanism made a simple variable stop motion

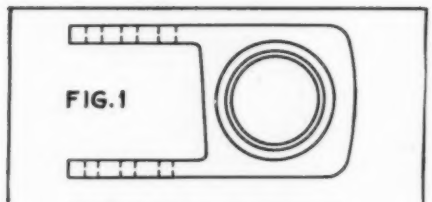
The function of the sliding nut is to provide a means for varying the interval between the starting and stopping of the machine. With the spindle *A* in its lowest position and the other parts in the same relative position as shown in the illustration, the nose piece on sliding nut will be almost as far from the latch lever *K* as the dimension *L*. By turning the spindle by its knurled knob the sliding nut can be raised or lowered, increasing or decreasing the distance between the nose piece *C* and the latch lever *K*, thus varying the distance the spindle is raised by the pawl *E* before the latch lever permits the clutch to be disengaged. The time interval can be further varied by changing the ratio of revolutions of the eccentric shaft to the work spindle of the machine.

Fitting Back Ends of Main Rods With Floating Bushings

H. D. ANDERSON

When changing the back ends of main rods from the ordinary brasses to floating bushings, it is common practice to make special strap-forgings, as in Fig. 1, and to bore the forgings for the floating bushings.

On an eastern road a number of back ends of main rods were equipped with forgings of this type, and it was discovered that some of the straps were "working" on the stub ends of the rods. In fact, some of them were so loose that they could not be closed down on the stub ends near the solid parts of the forgings. Also, when it was required to change some of the forgings to other main rods it was discovered that a slight variation in the size of the stub block.



Putting slots in locomotive rod straps makes it easy to close them over the stub end

ends made is impossible to make a tight fit.

One of the foremen visited a shop in another section and noted that the forgings were drilled and slotted as at *A*, Fig. 2, permitting the strap fits to be opened by a spreader for fitting. In assembling the forgings on the rods, the bolts would close the straps tightly on the stub ends, even if the stub ends were slightly undersize. The practice of drilling and slotting the forgings could be generally adopted to advantage.

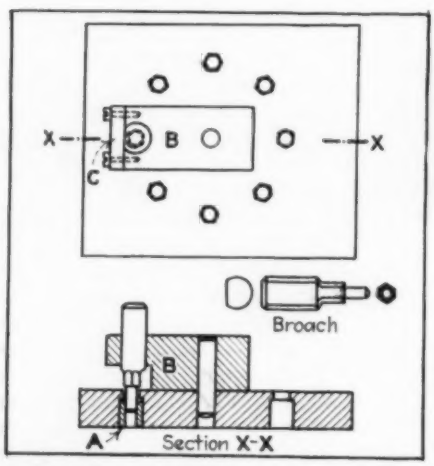
Short Cuts in Die Making

CHARLES KUGLER

In making a die for punching eight 1/8-in. holes in a circle in brass plates for slot machines, the following method was used in broaching the holes so as to eliminate filing.

The hole were equally spaced and drilled, using the dividing head of a universal milling machine. Then the holes were enlarged from the under side of the die for clearance. Two hexagon broaches were made and a flat was milled on the shank of each, parallel with one of the flats of the hexagon. The first, or roughing, broach was provided with a 3/32-in. round pilot. To guide the pilot, the bushing *A* was fitted to the clearance holes in the under side of the die. The second, or finishing, broach had a 1/8-in. pilot.

The block *B* was pivoted on the die in the center of the circle of holes and was drilled and reamed near the outer end to fit the shanks of the broaches. The end of this block was shaped off, cutting into the hole enough to match the flats on the broach shanks and the plate *C* was attached by screws. The function of block *B* was to guide the broaches by their flattened shanks and so keep the flats of the hexagons in the same relative position. With the broaches guided from below by the pilots and above by the flatted shanks, clean, accurate holes were easily broached.

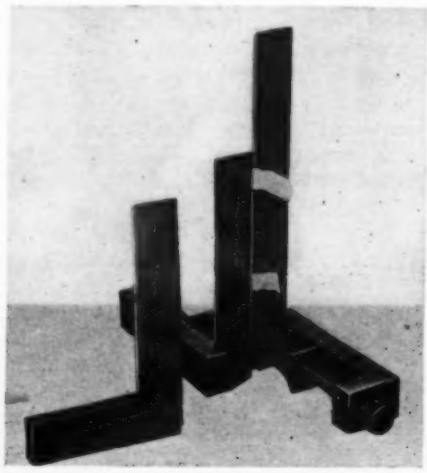


Broaching holes in dies instead of filing them saves time and does a better job

Testing a Square

W. H. MOORE
Hamilton, Ontario, Canada

Strolling into a small shop recently, I was just in time to hear the tail end of an argument about the accuracy of a certain square. The shop had no equipment for testing the square, and since words, however heated, would never settle the question, I set out to devise a method of doing the job with tools to be found in almost every machinist's toolbox. Two scales were held upright in separate clamps and placed together with the square to be tested on a surface plate. Each scale was adjusted so that one edge matched the blade of the square. Then these edges of the scales were brought into contact, thus any error in the square would be shown doubled. The illustration shows the scheme.



Checking the accuracy of a square by setting two scales against the square, and against each other

I have never seen this method described and, so far as I know, it was original with me.

Quick-Releasing Devices

H. P. CAMP

Three applications of a practical means for the quick release of work from threaded adapters are shown.

In Fig. 1 is an adapter fitted to the spindle nose of a lathe and holding a piece of internally threaded work. The freely rotating collar *A* is provided with two radially projecting lugs, the use of which permits easy release of the work after it has been tightened by the action of the cut. Removal of the work from the adapter is simple, no wrench, clamp or spanner being needed. Just stop the lathe and give a quick, sharp blow with a light hammer on one of the projecting

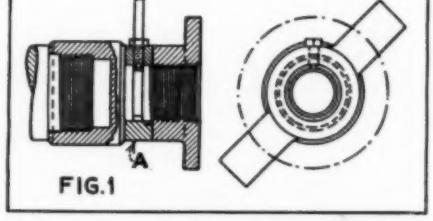


Fig. 1 — Quick release adapter fitted to spindle nose of any lathe

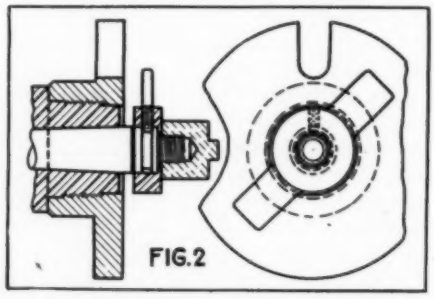


Fig. 2—Similar device fitted to the threaded end of a taper mandrel

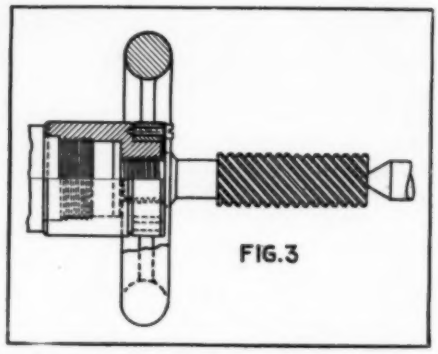


Fig. 3—Another use of the same method applied to a hobbing machine

lugs in the direction of unscrewing the work. This will release the pressure against the collar and the shoulder of the adapter and permit the work to be easily removed by hand.

The same device is shown in Fig. 2 in connection with work mounted on the threaded end of a mandrel held in the taper hole of the lathe spindle. In Fig. 3 is an application of a similar device applied to an adapter on the spindle of a hobbing machine. Here the end of the work is screwed into a threaded hole in the adapter, the collar having an inwardly projecting flange to act as a shoulder. Instead of having radial lugs, the collar is attached to a handwheel. The work is screwed into the adapter by the right hand until its shoulder is firmly seated against the flange on the collar. The handwheel is rotated in the direction of screwing in the work by the left hand, thus holding the work against rotation by the action of the hob. To free the work requires both hands on the handwheel, which is rotated in the direction of unscrewing the work, but even so, the release is easy, quick and convenient.

Revising a Milling Process

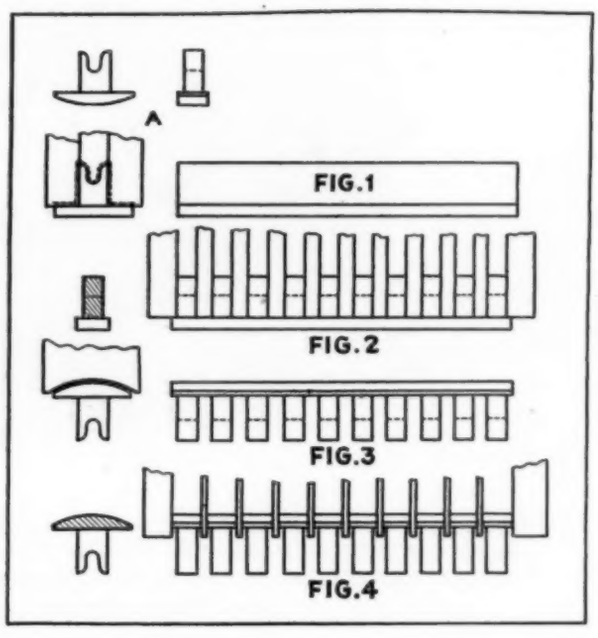
JOSEPH H. HAMM

In producing very large quantities of pieces like the one shown at *A*, we were milling each piece separately from pieces cut from bars of 5/8 x 7/8-in. cold-rolled steel, the work being done in a battery of eight milling machines served by one operator. In looking over the time studies, we found that the machines were continually waiting for the operator, entailing considerable loss in output. The obvious remedy was to arrange for longer cuts on some of the machines so as to give the operator more time for serving the machines that were necessarily devoted to short cuts.

To eliminate the idle time of the machines, the process was revised. Lengths from which ten pieces could be made were cut from bundles of six bars in a battery of six power hacksaws. The first operation is form and straddle milling lengthwise, as indicated in Fig. 1, the work being held in a vise having serrated jaws to prevent slippage. The second operation is cross milling for thickness of the stems. For this operation, nine 3/32-in. saws and two side mills are used, as shown in Fig. 2. The jaws of the vise are slotted to permit passage of the saws.

For the next operation, that of milling the curve on the heads, the lengths of stock are turned upside down and are held in a vise having ordinary jaws. The cut is lengthwise and is made by a formed cutter, as shown in Fig. 3. In the last operation, the pieces are severed from the stock by cross milling, leaving the heads of the correct width. In this operation, nine 1/8-in. slitting saws and two side mills are used, as indicated in Fig. 4. The vise has special jaws, slotted for the passage of the saws.

By this set-up, production was increased at a reduction of 75 per cent in cost. Also, the operator was enabled to serve the machines on the short, crosswise cuts from two to three times before the longer, lengthwise cuts had run out, thereby reducing the idle time of the machines to the minimum. In checking the cost of the form-milling operations against the cost of stock rolled or extruded to shape, we found that milling was cheaper.



With pieces milled separately the machines waited for the operator. Making fixtures to hold ten pieces reduced the cost of the operation 75 per cent

SEEN AND HEARD

JOHN R. GODFREY

Use Accurate Wires in Measuring Threads

Times have changed a lot since we used a pair of broad nosed calipers to measure the diameter of threaded parts, on the outside. The three-wire method has become standard and we have learned that, in most cases, the outside diameter is relatively unimportant. Some, however, fail to appreciate the errors that may arise from not using what is known as the best size wires. They want to use a drill shank or any old wire that happens to be handy. Proper wires are not costly and should always be available if we want accuracy. Errors in wire diameter are multiplied as much as eight times in some instances when used in small angle threads. Watch your wires if you want accurate results.

Chilled Iron Comes Back

Cast iron refuses to be downed by the newer alloys. Instead of giving up the ghost quietly its friends stage a new comeback in the shape of a strong and tough chilled cast iron that seems to have a field of its own when it comes to resisting wear. By taking a good base composition for chilled iron and adding 5 per cent of nickel and 2 per cent of chromium, a material is produced that shows 600 to 750 Brinell as against 380 to 530 for other chilled irons—and that is *some* hard. Chilled car wheels, rolls for rolling mills, coal crushers, sandblast nozzles and the like made of this mixture show a life of from four to six times the old standard mixture of iron, and in some cases it beats manganese steel in the same proportion. When you want a casting that is really hard don't forget to add the nickel and chromium.

Locating and Clamping Work

Here's a thought that deserves the attention of all shop executives, in large shops and small. An old friend points out that with mechanical feeds, labor simply handles material in and out of the machine. This, of course, includes setting and clamping the work as part of the handling. This particular shop over which he presides locates and clamps the work by simple devices that are operated by a single pull of a lever or by taking a bit of power from the feed mechanism, or movement of the machine itself. There are many opportunities to reduce locating and clamping time in shops of even small size.

SHOP EQUIPMENT NEWS

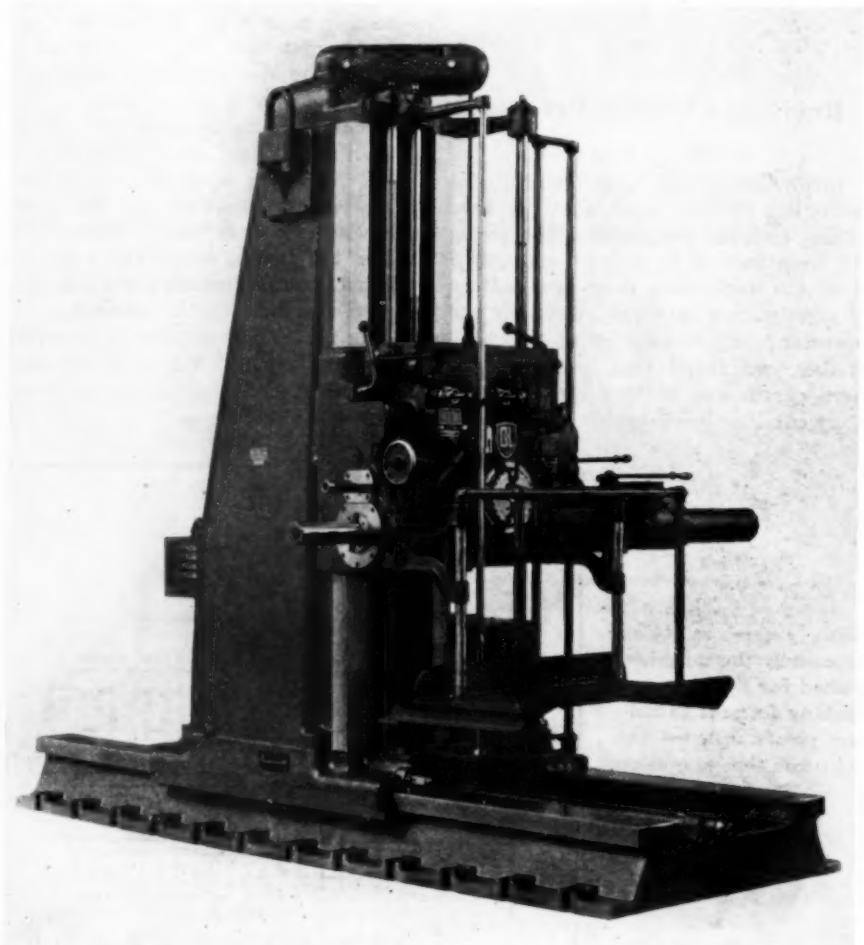
Giddings & Lewis No. 35-F Two-Spindle Horizontal Boring, Drilling and Milling Machine

A floor-type No. 35-F precision horizontal boring, drilling and milling machine has been added to its line by the Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. The two-spindle principle provides a main spindle of 3½ in. in diameter, running at speeds up to 500 r.p.m., and a high-speed auxiliary spindle running at speeds up to 1,500 r.p.m. The latter spindle permits drilling or boring of small holes or of using the smallest end mills, while the main spindle is used for the larger boring, milling and drilling operations. Each spindle has 36 speeds and 18 feeds arranged in geometrical progression. All speed changes are accomplished by means of sliding gears and jaw clutches through three levers located at the front of the head. A selecting lever permits the engagement of one or the other spindle. This lever also controls the application of the feed to either spindle. The 18 feeds are controlled through two levers, while a third controls the direction. Slow hand feed is applicable to either spindle by means of a handwheel at the front of the head. An automatic trip throws the feed out at any predetermined depth within a 6 in. spindle travel. Pick-off gears are incorporated in the train so that practically any range of feeds or any particular feed may be had.

A separate milling feed unit with 18 feeds with directional control is built into the spindle head, permitting the head to be fed up or down on the column or the column to be fed back and forth on the runway. The speeds and feeds applying at any time to the spindles or milling unit are shown on direct-reading dials. Hand feed adjustment is also provided.

Powerful clamping arrangements are provided for clamping the spindle head to the column and the column to the runway. The machine is controlled by the operator standing on a telescoping platform. All parts are automatically lubricated. The motor is placed at the bottom of the column on an adjustable bracket.

The machine can be furnished with a maximum vertical travel of the spindle head on the column of 96 in., and a horizontal travel of the column on the runway to meet requirements. Safety trips are provided at the end of each travel.



Directional control, direct-reading dials for speeds and feeds, and 36 speeds and 18 feeds to each of two spindles are found in the Giddings & Lewis No. 35-F Two-Spindle Precision Horizontal Boring, Drilling and Milling Machine

Murex Special Mineral-Coated Electrodes

The Metal & Thermit Corp., 120 Broadway, New York, N. Y., has added two special electrodes to its "Murex" line of heavy mineral-coated arc-welding electrodes. One is a special electrode designed for welding "Cromansil" steel, a high-strength steel having a tensile strength of 80,000 to 100,000 lb. per sq.in., along with high ductility. The electrode gives a deposit of the same analysis as Cromansil, and it is said that the weld metal has physical properties equal to the parent metal. The second electrode deposits a metal containing 4 to 6 per cent chromium and 0.5 per cent molybdenum, specially suited to the welding of refinery equipment.

Townsend Combination Drilling and Forming Machine

The H. P. Townsend Mfg. Co., P.O. Box 1206, Hartford, Conn., has made numerous improvements in its combination drilling and forming machine, or small automatic screw machine, using hopper or magazine feeds. The gear guard has been omitted in the illustration to show the gear train. The machine can be furnished with one of several types of feed for feeding headed screw blanks, special rivets, and studs, also straight blanks without heads, small tubes or shells with or without closed ends. The work spindle is of the two-jaw type, the jaws being opened and closed by toggle links operated by springs of different tension, according to requirements. The work spindle is fitted with oversize ball bearings. A feed finger feeds the blanks either head or point first into the spindle so that pointing, shaving, drilling or hollow milling operations can be performed on either end. By means of a properly formed tool mounted in the toolholder on the tool shaft, which appears at the front, the tool is rocked on the shaft for feeding and can be rocked straight into a forming cut or slightly sideways for shaving and pointing operations.

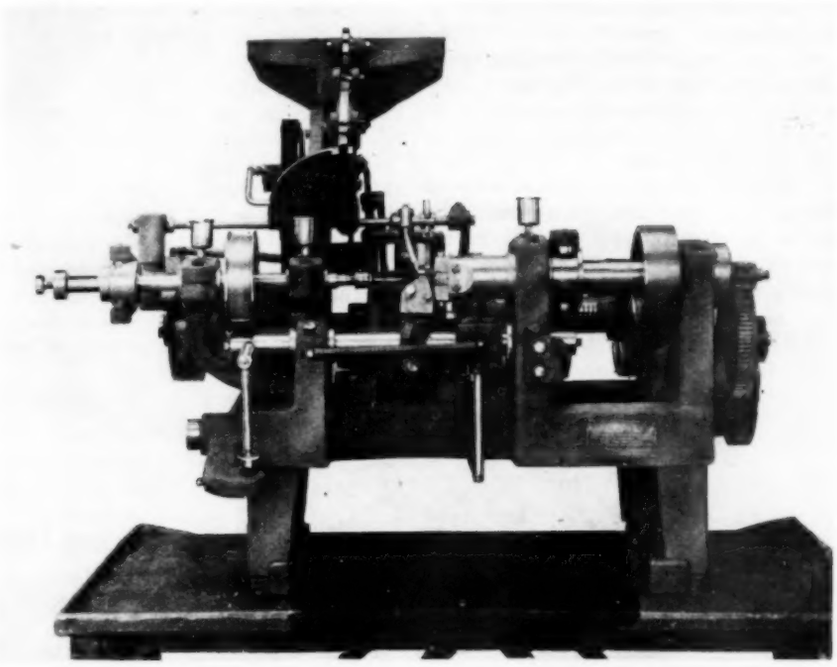


Fig. 1—Townsend Combination Drilling and Forming Machine, which is built in three sizes for handling work from the smallest up to 5 in. long by ⅝ in. in diameter

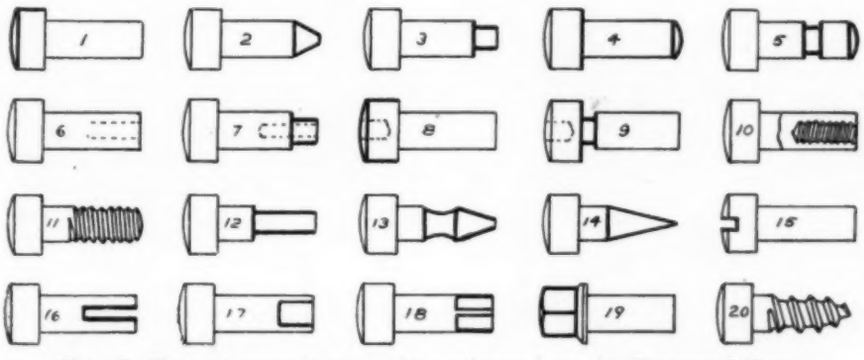


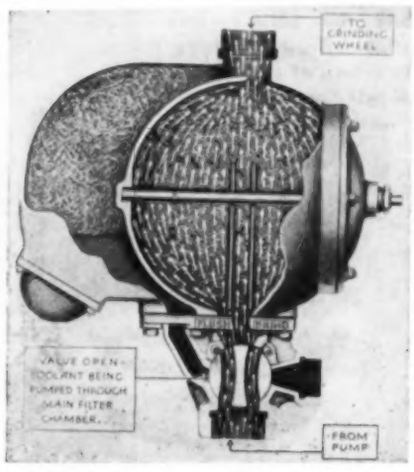
Fig. 2—Twenty operations can be performed on the Townsend Combination Drilling and Forming machine, using the same blank

The drill spindle is fitted with "Trump" chucks, which will carry from the smallest up to ¼-in. drills. The drill spindle runs in the opposite direction from the work spindle to increase the drilling efficiency. Hollow mills, as well as drills, may be used for reducing diameters too long for a forming operation. The cams, which operate both the forming tool and the drill spindle, are mounted on the left end of the camshaft and can be changed easily. All adjustments are easily accessible from the front of the machine.

The machines are furnished with tables which can be set up singly or bolted together so that a battery can be driven from an overhead lineshaft. Space is available underneath for storage. The three sizes built handle work from the smallest up to 5 in. long by ⅝ in. in diameter. They are made principally for light, rapid cuts, and according to the amount of metal to be removed and the work to be done, operate at from 6 to 90 pieces per minute.

Sorwal Coolant Filter

The Fostoria Pressed Steel Corp., Fostoria, Ohio, is now manufacturing and selling the "Sorwal" coolant filter for use with grinding and other machines. A fine grit wheel has a tendency to clog up which necessitates frequent dressing. Gummy coolant loads the wheel and scratches or burns the work, causing discoloration. The Sorwal coolant filter employs a non-metallic filtering material. It is cleaned without removing it from position by turning a valve and agitating a wrench handle for a short time. The accompanying illustration shows the normal operation of the filter by which coolant is forced by the pump through the globe containing the filtering material. By turning the valve from the grinding to the flushing position, the coolant flows through a by-passage also filled with filtering material, and back



through the main filtering chamber and out through a drain pipe to the receiving tank. At the same time a wrench placed on the end of a shaft extending through the main chamber is moved back and forth, compressing and agitating the filtering material by means of long rods placed at right angles on the shaft. This action cleans the main filter chamber.

Bullard Single-Spindle Automatic Vertical Lathe

"Flex-Au-Mobility," an expression coined by the Bullard Co., Bridgeport, Conn., connotes the qualities of flexibility, automaticity, and mobility possessed by its single-spindle automatic vertical lathe now being placed on the market. Either short-run or production schedules are handled efficiently because of the machine's fundamental design. Flexibility is secured by the three individually controlled slides—two universal, each with a swivel for angular cutting, and one plain vertical center slide. Electrical control provides for automatic operation of the machine. Its mobility permits shifting machines about in batteries or in single units and reassembling batteries as desired, of course being assisted by the flexibility of set-up.

Capacity of the machine is 10 in. in diameter by 32 in. in height, cutting with cross-slides, and 10 in. in diameter by 36 in. in height, cutting with the center slide. There is a possible swing in the clear of 18 in. in diameter by 17½ in. in height. Projected floor space is 57x67 in., and the weight is approximately 11,000 lb. without motors.

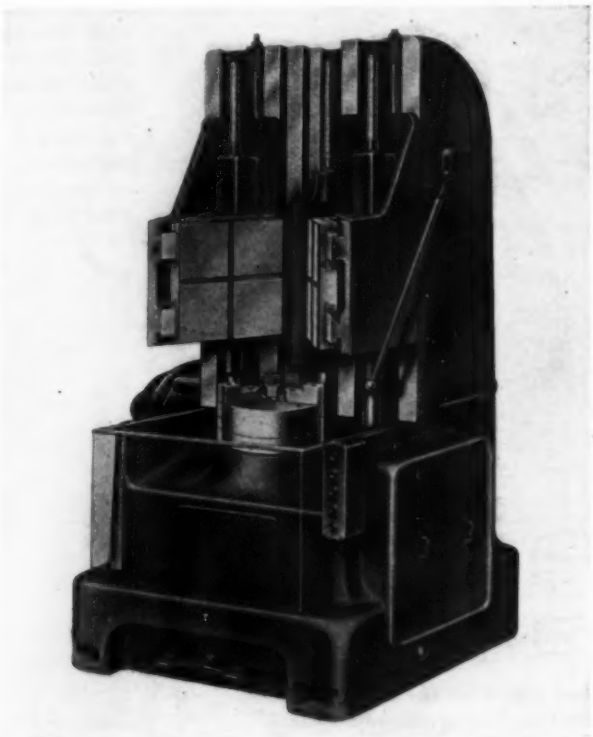
The feed mechanism for each of the three slides is designed to give a total stroke of 20 in. For chucking work the universal slides have a downward and inward movement, while the center slide has only a vertical movement. Application of the tailstock converts the machine into a center turning lathe, and then the universal slides may be changed to obtain inward, downward, outward, and upward movement. Rapid traverse for the three slides is obtained through an independent motor.

Simple, standard toolholders are easily clamped to the slides and also easily rarranged for varying diameters, change in work design, or for changes requiring complete change-over or set-up. Each of the three heads is provided with 80 independent feed changes obtained by means of change gears, and there are also 80 speed changes for the table, the maximum speed being 800 r.p.m. In the standard machine there is incorporated a two-way clutch, automatically controlled during the cycle, so that the spindle speeds may be changed in a ratio of 3 to 1, or a ratio of 1 to 3 from the basic spindle speeds. This clutch allows for slowing down or speeding up during the cycle of the machine to accommodate such work as sweeping, reaming, tapping, or threading at slower speeds, or finishing at higher speeds.

Independent motors are applied for the main drive, rapid traverse, and lubrication. These motors are electrically interlocked, and electric control is completely automatic during the cycle. It may be controlled independently by pushbuttons from the operating station. Tool setting flexibility is obtained by means of four electric pushbuttons—(1) emergency control which stops all functions; (2) the individual chuck motion; (3) the head traverse advance; (4) the head traverse return. A pushbutton controls the pump motor. The main drive motor is 20 hp., 1800 r.p.m., and the rapid traverse motor is 3 hp., 1800 r.p.m., both direct-connected. An independent ½-hp., 1800-r.p.m. motor drives the pump for the lubricating system. A 40-gal. reservoir contains the cutting coolant.

The steel spindle is mounted in Timken bearings, and supports the 3-jaw chuck which has a nominal rating of 12 in., but takes a maximum diameter of 14 in. The chuck is arranged with an inbuilt adjustable mechanical power chuck operator with treadle. Adjustment of the chuck jaw pressure is obtained by means of a screw located at the side of the machine, and the pressure may be regulated so that light as well as heavy pieces may be held securely.

Bearings throughout the machine are of the anti-friction type.



Simple toolholders on the two universal slides and the plain center slide afford flexibility in set-up of the Bullard Single-Spindle Automatic Vertical Lathe

Craley Off-Set Boring Head

Off-set boring heads for use on milling, boring and drilling machines are available in five sizes from the C. C. Craley Manufacturing Co., Shillington, Pa. In these tools overhang has been eliminated so far as possible. The head is made of steel, except for the gibs, which are of brass. The large graduated dial has 50 divisions. When set at zero with the dove-tail bearing flush with the head, the tool will run true with the spindle of the machine. The adjustment screw has 20 threads per inch so that movement of the dial one division sets the tool off center, exactly 0.001 in. Tool bits are held in place by standard socket-head screws. No. 1 and 2 heads are suitable for boring up to 4 in. in diameter, and shanks are interchangeable on these two sizes. Shanks are screwed into the head so that they may be used in different machine tools, at a slight additional cost for extra interchangeable shanks.

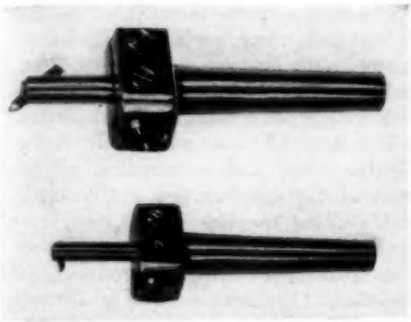


Fig. 1 — Craley Off-Set Boring Heads are built in five sizes, the largest for boring up to 14 in. in diameter

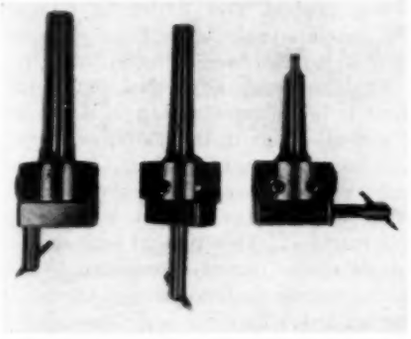


Fig. 2 — Craley No. 4 Off-Set Boring Heads with tool bits in position for boring holes from the smallest size up to 10 in. in diameter

In Fig. 2 is shown the No. 4 head with three different shanks, and with the cutting bit in position for boring holes from the smallest size up to 10 in. in diameter. The center head has the tool in position to run true with the machine spindle.

Boker Nickel-Clad Steel Sheets and Plates

H. Boker & Co., 103 Duane St., New York, N. Y., is now in a position to furnish hot rolled, annealed and pickled sheets from No. 16 U.S.S. gage up to and including heavy plate sizes, and also cold rolled sheets and strips with polished surface as thin as No. 32 gage. These sheets are made by hot welding under pressure a slab of pure nickel to a steel base. The nickel surface can be applied on one or both sides. For heavy equipment, such as tanks, the hot rolled, annealed and pickled sheets are generally applied, while for general trim, combined with corrosion resistance, cold rolled or polished sheets can be furnished where a brighter and smoother surface is desired. Nickel-clad wire can also be supplied with various percentages of cladding.

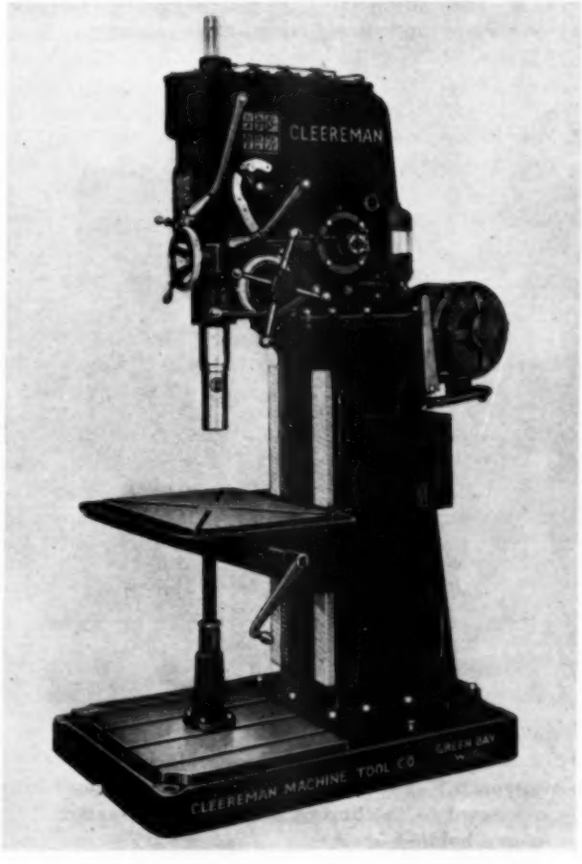
Cleereman High-Speed Drilling Boring and Tapping Machines

The Cleereman Machine Tool Co. (formerly Green Bay Barker Machine & Tool Works), Green Bay, Wis., for which Bryant Machinery & Engineering Co., 400 W. Madison St., Chicago, Ill., is national distributor, has built a line of heavy-duty drilling machines embodying greater power and rigidity and faster speed. A 30 per cent increase in the number of spindle speeds, and speeds as high as 1,700 r.p.m. are available in the six different sizes. Swing ratings are 20, 22, 24, 24, 28 and 28 in. Capacities are as follows: for the first three sizes, ½ in. in S.A.E. 1035 steel, the fourth size, 2 in.; the fifth size, ½ in., and the sixth size, 2 in. Nine changes of feed are in geometrical progression, ranging from 0.005 to 0.0833 in. per revolution.

Spindle and sleeve are made from heat-treated chrome manganese forgings. The spindle is journaled at the lower part of the sleeve in a heavy-duty roller bearing and at the upper part in a phosphor-bronze bushing. Thrust bearings are provided at both the upper and lower ends. The driving end is six-splined while the nose contains a standard Morse Taper. If necessary a hardened nose can be furnished or special, driving slots or threaded sections to suit conditions. A spindle revolution counter may be incorporated on the head to show the exact number of revolutions per minute.

The driving mechanism consists of thirteen gears from which twelve spindle speeds are secured. All gears and shafts are of chrome-nickel steel heat treated. Shafts are extra large with six splines and operate on heavy-duty anti-friction bearings.

Quick changes in speed are made through sliding gears and one positive-tooth clutch. The clutch is actuated by a four-spoke turnstile which is also used for quick traverse. A small handwheel mounted on the worm shaft provides a hand feed. The depth gage can be used for the full travel of the spindle by pulling out a plunger just before the tripping point makes contact. Tap leads consisting of 12, 18, 24 and 36 threads per inch are built into the feed mechanism. Pick-off gears can be supplied for any thread. The entire mechanism is protected by a sensitive overload safety device. The addition of two gears and one clutch converts the unit



Spindle speeds to 1,700 r.p.m., and greater strength and rigidity adapt the Cleereman High Speed Drilling, Boring and Tapping Machine to modern shop practice

into a quick reverse tapping attachment. Automatic reverse having a depth stop can be furnished. The machine is automatically oiled with filtered oil. The amount of oil necessary for proper operation of the spindle at various speeds can be adjusted quickly.

Either belt or constant-speed motor drive can be furnished. Gear connected, or built-in backgear motors are mounted on the side of the machine and connected to the primary shaft by means of a flexible coupling. Standard motors are mounted on the rear of the machine and connected by silent chain or V-belt to the primary drive shaft. The head is a unit within itself and can be arranged in gang style of from two to six spindles. It can also be built into special machines for multiple-spindle, single-purpose operation.

Various tables such as circular, compound and square can be furnished. Round-column machines may be had if desired. The company is in a position to furnish special feeds and speeds and special adaptations of this machine or its head to suit any condition.

Ex-Cell-O Single-and Double-End Junior Style Precision Boring Machines

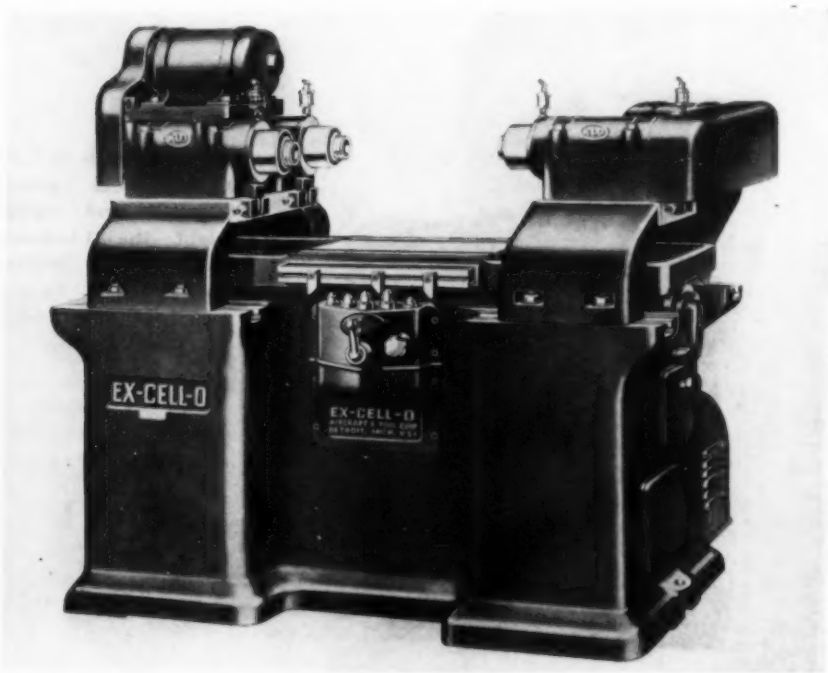
Short-production, high-precision work on such parts as connecting rods, pistons, gears, motor-end frames, refrigerator compressor bodies, seal rings and similar parts can be done on the single- and double-end Junior Style precision boring machines announced by Ex-Cell-O Aircraft & Tool Corp., 1200 Oakman Blvd., Detroit, Mich. The double-end, Style No. 1212, machine is illustrated. A bridge is provided at each end upon which one or two boring units are mounted. Two boring units with a drive motor mounted above them are illustrated at the left, and one boring unit with a motor mounted beside it is shown at the right. The type and number of boring units used depends upon each individual application. Each bridge is adjustable on its own rails, providing a maximum distance of 28 in. between boring units and a minimum distance of 12 in.

There are two different methods for driving the boring units, the inbuilt motor and the belt-driven type. When using the inbuilt type, a ¾-hp. motor rated at 1,800 or 3,600 r.p.m. is used. Only one speed can be obtained from this type. On jobs where a range of speeds is required, the belt-driven boring unit is used. A 1-hp., 1200-r.p.m. motor may be mounted beside the boring unit or directly above it, depending upon the number of boring units required.

The fixture table is provided with a V- and a flat-way, each lubricated from the hydraulic pressure system. A finished pad, 12x22 in., on the table is provided with T-slots for holding the work fixture.

The hydraulic control unit is of Ex-Cell-O design and is mounted on the front of the machine below the fixture table. Near the top of this unit is an oval plate which can be removed for adjusting the rate of table feed in each direction. Plungers extending through and above the top of the unit are operated by adjustable dogs located on the side of the fixture table. Any desired operating cycle can be obtained. At the back near the bottom of the machine and mounted in line are the main drive motor, coolant and hydraulic pumps. The machine occupies a floor space of 14½ sq.ft., and weighs 3,000 lb.

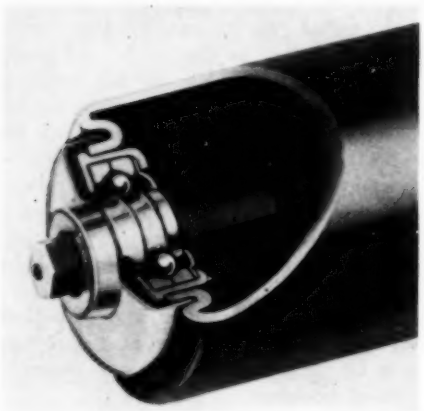
The single-end, Style No. 2112, machine is not illustrated but it is similar in general design to the double-end type. The same mounting bridge, hydraulic and coolant systems are employed. Another type of boring unit is used on this machine. This type of unit has an inbuilt motor directly connected to the boring spindle and mounted in one holding bracket. This unit and those shown on the double-end machine are interchangeable by the use of the proper bridge. To operate this machine the adjustable dogs, which operate the plungers on top of the hydraulic unit, are adjusted so that the high and low speeds, reverse and stop dogs conform with the required operating cycle. The machine is started by the hand lever located in the center of the unit, and the table is automatically stopped when through its cycle.



Ex-Cell-O, Style No. 1212, Double-End Precision Boring Machine employing belt-driven boring units. The single-end machine employs inbuilt motors directly connected to the boring spindle and mounted in one holding bracket

"Standard" Improved Gravity-Conveyor Roller

The Standard Conveyor Co., North St. Paul, Minn., has developed a gravity roller with ends formed in one piece to receive the bearing. This design makes for a stronger and truer running com-



bination. A recess is formed in the end of the roller to receive a stationary dust shield fastened on the inner ball race. An inner steel shield is also made a part of the bearing, fitting closely against the inner race to retain the grease. A hexagon axle prevents the inner race from turning, and a correspondingly shaped hole is punched in the side rails, making a positive lock at this point. The outer end of the bearing cone is counterbored so the grease can go completely around the shaft and through holes in the cone into the space allowed in the bearing and between the bearing and the shields. The grease can be renewed readily.

Porter-Cable Type D-4 Lapping Machine for Carbide Tools

The Porter-Cable Machine Co., Syracuse, N. Y., is offering the Type D-4 lapping machine for producing a dull-lapped finish on tungsten-carbide tools. The machine employs Carborundum Brand finishing compound, grading R40 fine, for the reason that it is less expensive than diamond dust, and that the dull lapped finish is claimed to be satisfactory for this class of work. Two disks are supplied, a larger cast-iron disk and a smaller hard wood disk to be mounted upon the cast-iron disk. The cast-iron lap leaves a dull-mat finish, whereas the wooden lap produces a semi-polish. The tool may be lapped freehand or it can be mounted in a sliding carriage. When using the Carborundum finishing compound, charging of the lapping disk is not necessary. Control of the machine is by a 2-pole toggle switch located on the motor.

The machine can be used to remove burrs and perform other types of freehand grinding after milling, pressing, stamping and screw-machine operations. It is also useful in assembly departments for removing surplus metal on fitting operations.

Specifications: Disk, 15 in. in diameter; height of disk, 39 in. from floor; motor, ½ hp.; net weight, 200 lb.; overall dimensions, 22x50 in.

Niagara M Series Shears

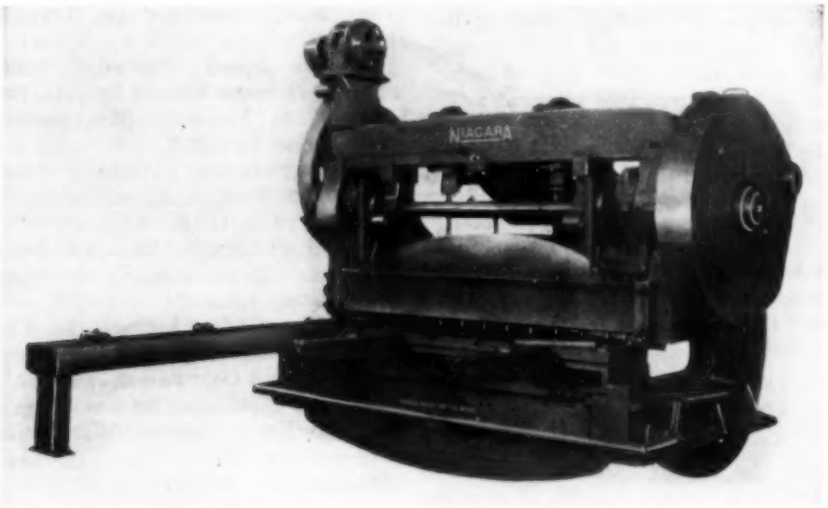
The Niagara Machine & Tool Works, Buffalo, N. Y., has developed the M Series shears for shearing heavy plates. Semi-steel castings made in heavily ribbed and filleted sections form the housings. Rigidity is achieved by bolting and doweling the semi-steel, box-section bed and crown to the housing. The box-section crosshead carrying the upper knife is counterbalanced by air cylinders connected directly to the regular shop air line. These cylinders operate with practically no loss of air in that the down stroke forces the air back into the shop supply. The eccentrics operating the crosshead are forged integral with the main shaft and are supported on both sides by bearings.

Each foot of the patented holddown is arranged with an individual spring cushion. The feet are self-adjusting for different thicknesses of material, building up pressure as the thickness of material is increased. Sheets of shorter length than the maximum cutting length of the shear are gripped uniformly without tilting the holddown, regardless of whether the sheets are cut in the center of the shear or at either end. The shear may be used for cutting the full capacity plate at one end and light gage plate at the other in the same stroke. By the use of an independent chuck for the lower knife it is possible to locate the bed permanently and to facilitate adjustment of knife alignment.

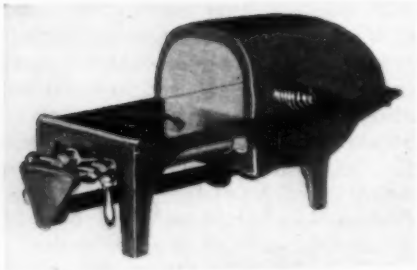
The jaw clutch has hardened tool steel inserts on both the striking and backlash surfaces. When the clutch mechanism is tripped by means of the foot bar, the main shaft makes one revolution and the shear stops at the top of the stroke. All gears have generated teeth for quietness. A belted motor drive is furnished. Illustrated is a short-center, flat-belt drive with the tension maintained by a ball-bearing idler pulley actuated by a compression spring.

"Red Devil" No. 20 2-Burner Gas Bench Furnace

A firebox temperature of 1,800 deg. F. can be attained in the No. 20 gas bench furnace now manufactured by the Red Devil Mfg. Co., Bellwood, Ill. Small carbon-steel tools, dies or parts can be heat-treated in the furnace which can also be used for melting small quantities of metal. The two burners are



In the Niagara M Series Shears the lower knife is carried in a chuck independent of the bed for proper adjustment, and each of the holddowns has an individual spring cushion



"Red Devil" Gas Furnace

placed parallel with the fire box so that the flame travels full length under the tool, strikes the curved well and is forced upward around the tool. The firebox is lined throughout with fire clay. Dimensions: Length, 15 in.; height, 7 in.; firebox, 5½ in. long by 5 in. wide by 4 in. deep. Gas consumption, 15 cu.ft. per hr. in each burner.

TRADE PUBLICATIONS

FURNACES. In Bulletin No. 8 the Ajax Electrothermic Corp., Division of the Ajax Metal Co., Trenton, N. J., shows "Ajax-Northrup" furnaces for melting and heat-treating, with complete information on each type.

MOTORS. Information on "Thermoguard" motors and their applications is contained in an illustrated circular announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. If the motor windings become overheated, the motor is disconnected from the line or a warning signal is given.

REDUCTION GEARS. The Poole Foundry & Machine Co., Woodberry, Baltimore, Md., has published a reduction gear catalog No. 33-RG describing the Poole single, double and triple herringbone gear units. Each type of reduction unit has complete information on dimensions, weights, horsepower ratings, speeds, ratios, on one page for simplified reference. Bed plates and couplings are also shown.

STEELS. The Firth-Sterling Steel Co., McKeesport, Pa., in a bulletin, "Firth-Sterling Products," describes its tool and alloy steels, stainless steels and sintered carbides.

STANDARDS YEAR BOOK. The American Standard Association, 29 W. 39th St., New York, N. Y., is distributing gratis the 1932-33 "American Standards Year Book" which incudes 31 new national industrial standards besides a classification of all standards in existence since 1918.

WHEELHEADS. The Heald Machine Co., Worcester, Mass., is now distributing a booklet "Heald Red Head." It describes the line of wheelheads for internal grinders as recently announced in these pages. The manufacture and testing of the wheelheads, together with sizes recommended for the various internal grinders are covered in the booklet.

PATENTS

MAY 30, 1933

Metal-Working Machinery

Grinding Machine. Carl R. Dahlin, Worcester, Mass., assigned to The Heald Machine Co. Patent 1,911,266.

Multiple-Drilling Spindle Machine. John Wilson Brown, Jr., Philadelphia, Pa. Patent 1,911,301.

Multiple Operation Multiple Spindle Drill. John Wilson Brown, Jr., Philadelphia, Pa. Patent 1,911,302.

Bossed Arm Drilling Machine. John Wilson Brown, Jr., Philadelphia, Pa. Patent 1,911,303.

Rotary Gang Drill. John Wilson Brown, Jr., Philadelphia, Pa. Patent 1,911,304.

Draw Press. Robert J. Pardee, Cleveland Heights, Ohio, assigned to The Cleveland Punch & Shear Works Co. Patent 1,911,385.

Grinding Machine. Raymond A. Cole and Albert G. Belden, Worcester, Mass., assigned to Norton Co. Patent 1,911,552.

Machine for Precision Grinding. Raymond A. Cole and Albert G. Belden, Worcester, Mass., assigned to Norton Co. Patent 1,911,553.

Multiple Chucking Machine. Arthur J. Lewis, Stratford, Conn., assigned to The Baird Machine Co. Patent 1,911,632,

Grinder Speed Control. Walter Stumpf, deceased Towson Heights, Md., assigned to Marschke Manufacturing Co. Patent 1,911,857.

Grinding Machine. Warren F. Fraser, Westboro, Mass., assigned to Norton Co. Patent 1,911,889.

Grinding Machine. Warren F. Fraser, Westboro, Mass., assigned to Norton Co. Patent 1,911,890.

Machine Tool. Charles B. De Vlieg, Rockford, Ill., assigned to Sundstrand Machine Tool Co. Patent 1,912,033.

Feeding Mechanism for Screw Threading Machine. Samuel W. Mathias, Waynesboro, Pa., assigned to Landis Machine Co. Patent 1,912,340.

Tools and Attachments

Chuck and Chuck Indexing Mechanism. Samuel W. Mathias, Waynesboro, Pa., assigned to Landis Machine Company. Patent 1,912,339.

JUNE 6, 1933

Metal-Working Machinery

Milling Machine. Ernest J. Svenson, Rockford, Ill., assigned to Sundstrand Machine Tool Co. Patent 1,912,413.

Automatic Machine Tool. William S. Davenport, Rochester, N. Y., assigned to Davenport Machine Tool Co., Inc. Patent 1,912,515.

Machine Tool with Chip-Removing Means. Frank L. Cone, Windsor, Vt. Patent 1,912,622.

Nut Threading Machine with Straight Shank Tap. Eric M. de Sherbinin, Merion, Pa., Victor E. Pearson, Buffalo, N. Y., and Edward H. Ingram, Philadelphia, Pa., assigned to Helen Koch de Sherbinin. Patent 1,912,764.

Tools and Attachments

Device for Dressing Grinding Wheels. William Shotey, Detroit, Mich. Patent 1,912,410.

Means for Threading Nut Blanks. Otto H. De Lapotterie, Kent, Ohio, assigned to Roy H. Smith. Patent 1,912,517.

Cutting Tool. Andrew W. Swanson, Chicago, Ill., assigned to Wedge Lock Tool Co. Patent 1,912,666.

Apparatus for Forming Flanges. William H. Brett, Shaker Heights Village, Ohio, assigned to The Enamel Products Co. Patent 1,912,930.

Processes

Method of Producing Metallic Dies. Kirbey W. Couse, Taos, N. Mex. Patent 1,912,889.

Welding Process. Howard J. Kerr, Westfield, N. J., assigned to The Babcock & Wilcox Co. Patent 1,912,901.

JUNE 13, 1933

Metal-Working Machinery

Drill Bit Grinding Machine. Charles V. Rice, Cresaptown, Md. Patent 1,913,771.

Crank Shaft Lapping Machine. Sydney Player and Herbert S. Indge, Westboro, Mass., assigned to Norton Co. Patent 1,913,854.

Drill Sharpening and Swaging Machines. James Rule, Cornwall, England, assigned to Holman Brothers Ltd., Cornwall, England. Patent 1,914,170.

Tools and Attachments

Gear Cutter. Ernest C. Head, Rochester, N. Y., assigned to Gleason Works. Patent 1,913,486.

Tolerance Gauge. Wilhelm Kaufmann, Hartford, Conn., asigned to The Hanson-Whitney Machine Co. Patent 1,913,674.